THE NATURE OF CONSTRUCTIONAL APRAXIA

in

SENILE DEMENTIA

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C O N T E N T S.

INTRODUCTION.

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Senile Dementia is a term used to define a condition of the senium in which there is progressive disintegration of those abilities which collectively are regarded as the intellect. Concurrently there occurs a decline in emotional responsiveness, which together with the intellectual impairment give rise to behaviour which in quality is both foreign to the earlier personality of the sufferer and inadequate to dealing with the demands of simple environments.

The intellectual deterioration in senile dementia is usually described in terms of a group of general defects of which dysfunction of certain aspects of memory have predominance. This group includes other defects of a general kind. One is disorientation, by which the demented individual shows himself to be dissociated from the realities of the temporal order of experience in the environment. Another is disturbance of thinking, whose output is diminished and whose content shows defects of selecting and grouping, and yet another concerns attention which on the whole is seized and shifted with difficulty.

Memory, orientation, thinking and attention are labelled "general" in as much as their function as skills is invariably involved in another order of abilities designated "special". The latter may function to some degree independently of one another but not independently of the general abilities listed above. They include the function of speech, visual, tactile and auditory perception, numerical ability, constructional ability, body awareness, spatial orientation, and motor skill. It is uncommon to consider the behaviour of senile dementia in terms of defect in these special

abilities, but there might be something to be said for this approach if thereby phenomena could be described more precisely, and in the more certain knowledge that, as is not the case in the general intellectual abilities, one was dealing with more mutually exclusive functions. The investigation of a second order of abilities of this kind could be undertaken properly only if the investigator was aware beforehand that the resulting pattern of defect might be determined in a complex way; in other words that it might be due to intrinsic dysfunction of the special ability, or that the special ability's function might be altered in consequence of a general intellectual disturbance, or that an intrinsically disturbed special ability might be influenced by general intellectual dysfunction.

Though one cannot justify the defects in a system by drawing attention to the defects in a possible alternative system, it must be pointed out that in describing senile dementia in terms of general intellectual abilities only, one has had to be equally alert to the possibility of complex determination of the pattern of defect. The defective functioning of any one of the four general abilities already mentioned may influence the expression of the others. For example attention defect may affect the function of memory, thinking and temporal orientation. Memory defect may disorder thinking, and temporal disorientation may distort memory. Indeed there is no certainty that these general abilities are discrete semantically, or are mutually exclusive in the sense that, in dysfunction, memory defect, for instance, can also be described in temporal disorientation, or as a disturbance of thinking.

Members of the group of special abilities on the other hand can be more meaningfully said to exist exclusively. Spatial disorientation can occur without a defect of speech. Defect of complex

motor skills are known to occur without visual perceptual disturbance.

It is these relative qualities of the special abilities over general abilities which make the former a suitable and perhaps preferable grouping of skills for study in senile dementia. The field of the present study is one of the group, viz. constructional ability in senile dementia.

Constructional ability more than the other special abilities lends itself to precise study for a number of reasons. The term construction can be defined clearly so that the limits of the matter under study are well circumscribed. Performance does not demand the vehicle of words in response. The patient leaves his own record in drawing or building or arranging. These responses allow more direct analysis and the ambiguity of verbiage does not have to be penetrated. The nature of the tests conventionally used to investigate constructional efficiency thus allows direct examination of behaviour.

To construct is to fit together, to build, to draw or to delineate. There is a strong implication in the word itself and its synonyms which suggests that form or wholeness or gestalt is aimed at in this activity, which in its turn implies that the circumstances of the starting point are both disorderly and fragmentary. In practice units, which may be bricks, sticks, or lines on paper, are fitted together and made in such a way as to be something more and something different from the sum of the units they contain. In block and stick design the units are prefabricated. In drawing even the units of construction have to be manufactured by the patient. The way the units are fitted together depends in the

test situation on the nature of the instructions given. The variety of things the patient may be asked to construct is infinite. The conditions under which construction is required to occur are restricted to copying from a model, reproducing from immediate memory of a model and spontaneous reproduction, i.e. construction from verbal instructions only, without reference to a model at all.

The above operative definition of construction does not conflict with that of Kleist (1924) who first used the term constructive apraxia in relation to this syndrome. He used this short description of it as a disturbance appearing in the formative activities (arranging, building and drawing) in which the spatial part of the task fails though there is no apraxia of single movements.

The literature reviewing this subject can be discussed in terms of its primary preoccupation. Earlier authors were concerned mainly with the nature of the defect irrespective of the site of the lesion producing it. More recently attention has been directed to the varied parts that defect in the two hemispheres have to play in the production of the total defect, and in particular the role of right-hemisphere dysfunction associated with visuo-spatial agnosia. The early authors appeared to disregard the laterality of the lesion on the assumption that the left (dominant) hemisphere must be involved where either apraxic or agnostic defect was manifest. Constructional apraxia was in question as a syndrome only in so far as it was justified to describe it as an apraxic defect or an agnostic one, or one in which both apraxic or agnostic defects were involved.

The earliest recognition of construction defect was on the whole incidental. Rieger [1] (1909) drew attention to the role of

"spatial brain function" but did not distinguish constructional apraxia from ideokinetic apraxia which he likewise attributed to a disturbance of spatial order. Liepmann [2] (1912) describes a case in which there is evidence of constructional difficulty but excludes a spatial disturbance because visual recognition is intact and attributes the defect to ideatory apraxia. Reichardt [3] (1918) comes nearer to the modern concept in stressing that the kind of agraphia caused by visual spatial disturbances is distinct from ideokinetic apraxia. Balint [4] (1909) used the term "optic ataxia" which was wider than, but included within its framework, what we would now call constructional apraxia. Optic ataxia was regarded by Balint as due to defects of visual localisation and visual attention.

Kleist [5] (1934) who advanced towards the current notion of the syndrome, viewed it as taking origin in a defect of the mechanism concerned with visuo-kinaesthetic associations. In other words Kleist takes up what is now the common view that in constructional apraxia motor skill is involved only where it is in operation in association with the act of spatial perception of certain aspects of the environment. Poppelreuter [6] (1917) describing earlier a similar defect though one rather wider in concept as "optic apraxia" concluded that a mechanism producing harmony between visual and motor activity was at fault. Pötzl [7] (1928) goes perhaps even further in suggesting in a case description that spatial perception is undisturbed where motor activity (copying) is not required in response. Where geometrical figures must be perceived in order to be copied then the concept of direction in space is disturbed and the copy is thereby distorted. This suggests that both perceptual and executive function operate intact unless they are

required to operate together. Kleist in contrast assumes a basic disturbance of spatial perception, though not of executive ability. Van den Horst [11] (1934) questions Kleist's view of constructional apraxia as a disturbance of optokinetic associations. This author regards as disturbed, both the formation of the mental image of a movement to be carried out and the perception of the object involved. He regards spatial disturbance as the underlying link between these two defects and as possibly producing them. Van den Horst's conclusion must be therefore that the whole defect should be viewed as an agnosia.

Mayer-Gross in an extensive examination of the subject between 1935 and 1936 dealt more specifically with the nature of the spatial defect in constructional apraxia. Reviewing 6 cases (1935) [8] he sees the disturbance as spatial in origin only in so far as the space concerned is what he calls activity space (Wirkraum); that is the operational space encompassed by the fingers and hands. He tends towards the original view of Kleist in thinking of this form of apraxia as one of the apractic syndromes. In a second paper Mayer-Gross [9] (1936a) as an aid to the evolution of his notion of the disturbance as a whole, refers to the views of Feuchtwanger [10] (1930) who tried to distinguish components in a constructional task in these terms.

(1) The idea of the completed work.

(2) The design of the work as a whole, i.e. the image of it which must be present when activity begins.

(3) The constructional plan, i.e. the picture of the partial activities which lead to the formation of the whole, and of the temporal sequence in which they occur.

(4) The technique, i.e. the more or less automatic movements of the performing limbs.

Feuchtwanger regards a failure of technique (4) as constituting apraxia, and failure of sensory control (1, 2 and 3) during activity as the feature of constructional disability. In other words Feuchtwanger proposes to regard the defect as a kind of agnosia. While Mayer-gross is inclined to uphold his own view of the disturbance as an apractic one he is clearly influenced by the other author in his own conclusion that constructional apraxia "can be characterised as an inability when given a real or imaginary visual pattern as a whole, to analyse it, piece by piece, in order to construct it again piece by piece"; a sequence which he admits must involve both gnostic and praxic function.

In yet another paper on the subject Mayer-Gross [12] (1936b) examines executive motor function as a whole in apraxia in the light of Jackson's [13] (1937) principle of "reduction to a more automatic condition" which it is shown is not borne out by the evidence of the evidence of the preservation of constructional ability (a non-automatic activity) in cases where handwriting (an automatic activity) is impaired.

Stengel [14] (1944) discusses the spatial aspects of constructional apraxia in a wider context in a case who not only shows the disturbance under review but also spatial disorientation and Gerstmann's syndrome. The author's case is said to have replaced the complex organisation of spatial relations in the environment by a primitive notion of space the only measure of which is nearness, which would account among other things for Mayer-Gross's "closing-in" sympton (undue approximation of the copy to the model). Stengel views all the abnormalities in his case i.e. spatial disorientation, constructional apraxia and Gerstmann's syndrome as the varied outcome of a common cause viz. the inability "to comprehend the outer world as it

presents itself visually as an organised whole wherein objects are related to each other and to ourselves according to certain laws learned by experience". Critchley [15] (1953) sustains the common view again. While he describes constructional apraxia in terms of the agnostic disturbance as "..... a rather delicate index of disturbed spatial relationships" he goes on to say "that the defects which characterise constructional apraxia involve those movements which are directly concerned with space per se, i.e. manipulation of three-dimensional space and particularly the translation of an object from one spatial dimension into another". The defect has, in other words, both executive and perceptual elements. Paterson and Zangwill [16] (1944) in a paper which will be discussed more fully later, found in their cases a disorder of spatial analysis only when an executive response was demanded. Ettlinger, Warrington and Zangwill [17] (1957) account for constructional apraxia in some of their right-sided lesion cases in terms of a dissociation between the visual and kinaesthetic aspects of muscular control.

There are only few exceptions in the above review to the general consensus of view regarding the nature of constructional apraxia; first that it involves a disturbance of both executive and perceptual function; secondly that it is distinct from the ideokinetic type of apraxia (Liepmann); and thirdly, that it is a disturbance which takes place in special circumstances, i.e. where movements occurs while organising objects in space. Van den Horst and Feuchtwanger, who view the disturbance as a form of agnosia, contrive this only by excluding an integral part of the total process from the definition or by confining that part of the function which involves movement to the realm of imagery.

The majority view on this subject; namely that constructional

apraxia is a function where both executive and perceptual abilities are involved, does not conflict with the view of Stengel among others, that this form of disturbance is but one manifestation among a group which depend upon a common cause. The group in this view might contain finger agnosia, acalculia, agraphia, and right-left disorientation; the common cause, a peculiar spatial disorder.

The other major preoccupation of those who have been concerned with the study of constructional apraxia relates to the cerebral localisation of the responsible lesion. Recent work has seen this as a matter of doubt requiring further study. Those who wrote earlier made assumptions about the hemisphere involved which have subsequently proved to be not entirely valid. Thus Poppelreuter [6] (1917) and Pötzl [7] (1928) both regarded the disability as taking origin in left-sided lesions. Kleist [5] (1934) also regarded left-sided lesions as those responsible for constructional apraxia though many of his cases showed bilateral lesions, and in quoting a right hemisphere lesion case of Reichardt, Kleist assumes there must have been pathology on the left which the other author neglected. One can hardly avoid the conclusion that Kleist had prejudged the matter.

Mayer-Gross [8] (1935) described a series of 6 cases in which the pathology was almost certainly bilateral in 4, and unilateral perhaps, but on the right, in the other 2. Steele and Hegarty [18] (1950) describe a case of carbon monoxide poisoning, which must be regarded as producing a diffuse lesion, in which the broader syndrome described by Stengel resulted i.e. spatial disorientation, constructional apraxia, Gerstmann's syndrome and dressing apraxia. Stengel [14] (1944) infers (though not only on evidence from the case which he reviews) that constructional apraxia and Gerstmann's syndrome are incomplete manifestations of the larger syndrome which his case demonstrates,

viz. the association of loss of spatial orientation, constructional apraxia and Gerstmann's syndrome. He assumes that in isolation, constructional apraxia and Gerstmann's syndrome are expressions of dominant hemisphere lesions of the angular gyrus while in cases with spatial disorientation the same localisation of the lesion is found bilaterally. Stengel here admits that his authority for the laterality of lesions responsible for constructional apraxia is the literature, for he had no anatomical findings in his case. Critchley [15] (1953) in a large review of the subject places the site "somewhere within the retro-rolandic region of the brain." With regard to sidedness he says "it may occur in association with lesions bilaterally placed, or right-sided or left-sided." He goes on to say that where there is complicated visual disorientation lesions are usually bilateral; "less complex cases however are instances of unilateral disease."

The notion that the right hemisphere might be involved in constructional apraxia was first seriously considered by Paterson and Zangwill [16] (1944) and (1945) [19] who indeed claimed that all cases hitherto had been described only after bilateral, often diffuse, lesions or after a lesion predominantly involving the parietal occipital area on the left. They reported 2 cases (1944) and another (1945) showing the defect in association with a unilateral right-sided lesion. Constructional apraxia in their cases differed from that associated with left-sided lesions in lacking associated symptoms, i.e. aphasia and apractic symptoms. McFie, Piercy, and Zangwill [20] (1950) describe further right-sided lesion cases in whom they attribute the greater part of the constructional disability to the neglect of the left-side of visual space and a disorganisation of discriminative spatial judgment. Nevertheless they would not commit themselves to vesting the minor hemisphere with a special significance in

constructional defect distinct from that of the major one.

Hécaen, Ajuriaguerra and Massonet [21] (1951) describe 6 right-sided lesion cases in whom constructional apraxia was predominantly disturbed, with impairment of reproduction of perspective in drawing, and the representation of spatial relations. There was evidence of central vestibular disturbance as well. They suggest that these defects together with evidence of unilateral spatial agnosia and defect in articulating units of two-dimensional drawings distinguishes the right from the comparable left-sided lesion constructional apraxia. Thus the lesions of right and left hemispheres are now distinguished.

The most contemporary writing on this subject takes the investigation a stage further by contrasting right and left-sided lesions and their resulting constructional apraxia in the one study. Piercy, Hecaen and Ajuriaguerra [22] (1960) contrast unilateral right and left-sided lesions,and find that the defect is both commoner and more severe on the right; a discrepancy not wholly explained, they say, by the masking effect of paresis, dysphasia, or unilateral imperception. Their conclusion is that the right hemisphere in right-handed people has a role which is not subordinate in respect of constructional apraxia. They put the hypothesis that this disability may result from one of two different functions represented respectively in the right and left hemispheres; right-hemisphere lesions involving greater impairment of perceptual functions and left-hemisphere lesions involving greater executive dysfunction.

In a paper published simultaneously with the above McFie and Zangwill [23] (1960) examine more precisely the spatial nature of constructional apraxia associated with left-sided lesions. They conclude that the difference between the groups of left and right-

sided lesions lies in the associated manifestations of conceptual spatial impairment and of other forms of intellectual impairment. They say that tests requiring little manipulation but considerable understanding of spatial properties were failed by those with right-sided rather than by those with left-sided lesions. On the other hand left-sided lesions are frequently associated with deficit in other intellectual functions (language, calculation, abstraction, dyspraxia of the "lower type"). Constructional apraxia in left-sided lesions was found by these authors to be rarely associated with unilateral neglect, dressing apraxia or failure in tests requiring spatial analysis. The suggestion is therefore that constructional apraxia in left-sided lesions is essentially different from that of right-sided lesions.

This last comment on the subject dealing with the contrast between right and left-sided lesion constructional apraxia probably summarises best the composite views of those who have considered the matter from this aspect since Paterson and Zangwill took up the question in 1944.

The aim of the present study is to define the character of constructional apraxia in senile dementia. The latter process is by definition one which is associated with bilateral cerebral damage which is moreover, diffuse over the cerebrum. One might expect the defect resulting from such a widespread lesion to have a character which would be difficult to describe in terms of impairment of individual function. The purpose of this study is to show that a recognisable constructional defect is demonstrable in senile dementia, and as far as possible delineate those aspects of the total defect which are specific from those which are general.

The performance of constructional tasks by a patient group will be compared with a group of normal aged, and discrepancies of performance will be discussed. It is hoped that this investigation will make a contribution to knowledge of the nature of constructional apraxia as a defect occurring under any circumstances.

METHOD OF INVESTIGATION.

SELECTION OF PATIENTS. This study is based upon 40 consecutive cases of senile dementia admitted to the Crichton Royal Hospital between April 1958 and April 1959. For inclusion in the series diagnosis of these cases was made in the first place in a conventional way. It was based upon an allegedly characteristic history of insidious and gradual and uniformly progressive course of memory defect temporal disorientation and affective and behavioural change. The diagnosis was also based upon psychiatric examination of a conventional nature in which the emphasis was largely placed upon the elicitation of signs of defect in what have already been defined as the general intellectual abilities. To achieve the greatest possible degree of homogeneity in the selected morbid group, those cases who were known to have a history of "strokes" "dizzy turns" "fits" or "blackouts" were excluded, as were those who on neurological examination after admission to hospital showed signs of pyramidal motor disturbance. No patient was selected who was under 65 years of age. According to these criteria 8 men and 32 women were included. The mean age of the whole group was 77.87 years, of the men 76.00 years, and of the women 78.34 years.

To have some standard performance with which to compare the efforts of the patient group, a group of 20 old people, selected from

the community, were asked to do the same series of tests. This control group was chosen from the membership of an Old Folks' Welfare Club in the town of Dumfries. None was in hospital. They attended this club once a week. All travelled to the club on their own, on foot, or by public transport. Many also attended other club meetings in the town. None had had ascertainable cerebro-vascular accident. A few had had "dizzy turns". All chosen cases were over 65 years of age. There were 9 men and 11 women. The mean age of the whole control group was 77.55 years: of the men 78.22 years and of the women 77.00 years.

SELECTION OF TESTS. 13 tests were chosen to investigate the 2 groups just described. They all fall within the category of tasks requiring constructional ability for their successful performance. Most of them are tests in common use in neurological diagnostic practice. None is standardised. The Kohs' blocks test for which there are norms has, in this investigation, been modified in order to achieve a scale which approximates more closely to the expected range of performance of the morbid group. The only other tests for which standards have been described is the Bender-Gestalt [24] (1938). This could not however be described as a standardised test, and again, one part of it has been modified in this investigation to meet the range of response expected from those with senile dementia.

The tests are listed as follows.

1. Spontaneous drawing of simple geometrical figures.
2. Copying simple geometrical figures.
3. Spontaneous construction of simple geometrical figures with matchsticks.
4. Copying simple geometrical figures with matchsticks.
5. Copying Abelson's figures.
6. Copying Bender-Gestalt figures.

7. Reproduction of Bender-Gestalt figures from immediate memory.

8. Spontaneous drawing of house, man, tree and bicycle.

9. Assembly of Wechsler-Bellevue mannikin.

10. Copying plain block designs.

11. Reproduction of plain block design from immediate memory.

12. Copying Kohs' blocks from a printed design.

13. Copying sticks in plasticine (v.i.)

These are now described more fully.

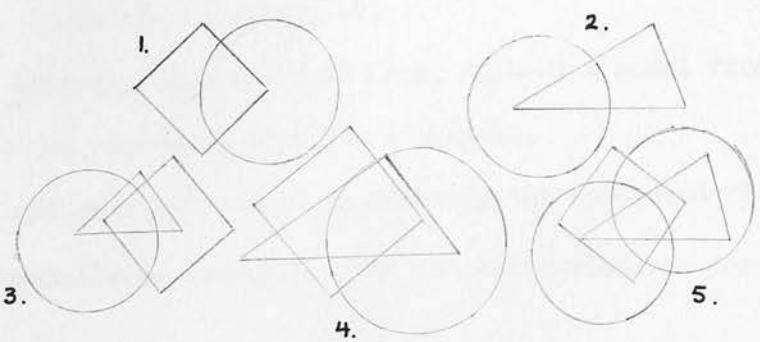
1. The patient is asked to draw on paper with a pencil five simple geometrical figures, viz. square, circle, cross, triangle and diamond. The last two figures are further described to the subject as a "three-sided shape" and "(a diamond) as you would see in a pack of cards."

2. The five shapes in Test 1 are presented to the subject already drawn, down the left-hand side of a quarto sheet of paper and the patient is asked to copy each figure on the right of the model figure.

3. The patient is asked to construct with matches strewn on the table three simple geometrical figures, viz. square, cross and triangle.

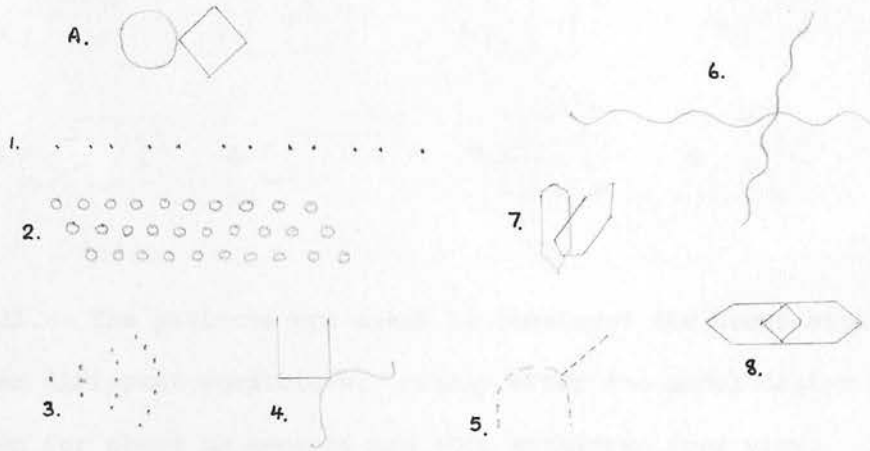
4. The three shapes in Test 3 are constructed by the examiner with matches and the patient is asked to copy these models using matches in his design.

5. The patient is asked to copy the illustrated five designs (Abelson's figures), which consist of intersecting simple geometrical figures. Each design is already drawn on a card which the patient must copy.



Two designs contain only two simple geometrical shapes. Two contain three and one has four. Only diamond, circle and triangle are used in the total designs. After copying, the subject is then asked to describe which shapes go to make up the whole design on each card.

6. The patient is asked to copy the nine designs of the Bender-Gestalt series. Each design is presented on a card for copying. The designs are as follows:



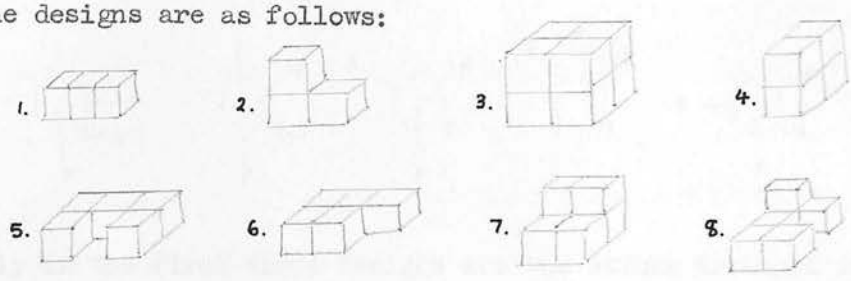
7. The first A and last 8 of the above Bender-Gestalt designs are shown to the patients for about 10 seconds after the patient has been told that he will be asked to reproduce the design when the card is withdrawn from view. At this point it must be said that this test is difficult, and its difficulty was such as to make the complete series too much of a burden to the patient to present as a whole. To have to persevere over nine items of a test, all of which one is likely to fail severely, can be irritating and certainly was to all those senile cases who attempted it.

8. The patients were asked to draw, without a model from which to copy, a house, a man, a tree and a bicycle.

9. The patients were asked to identify the scattered pieces of a Wechsler-Bellevue mannikin. If identification was correct,

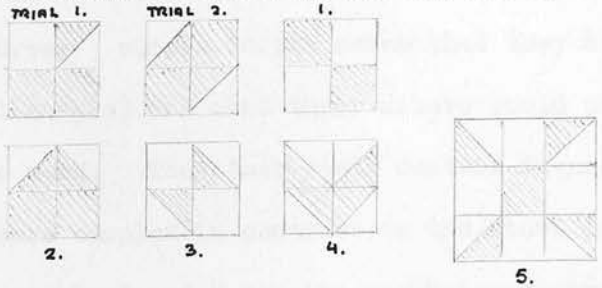
the subject was then told to assemble it. If he failed to identify the scattered pieces, their nature was explained to him and he was then told to construct the mannikin.

10. The patients were asked to copy with plain blocks (rather larger than Kohs' blocks) a series of eight designs already constructed by the examiner. The patient was given a number of blocks larger than the design required as material for his construction. The designs are as follows:



11. The patients are asked to construct the above eight designs under different conditions; namely after the model design has been shown for about 10 seconds and then withdrawn from view. Instructions are given beforehand that they would be asked to perform the task thus.

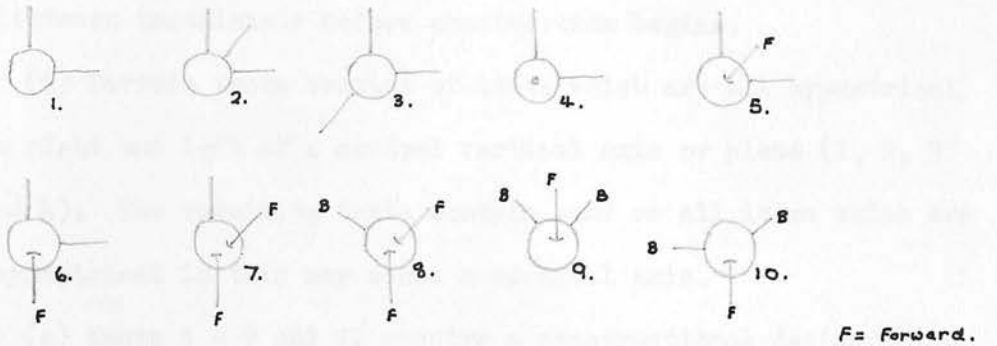
12. The patient is asked to construct certain items of the Wechsler-Bellevue version of Kohs' blocks. The construction of the first two items is demonstrated by the examiner and the patient is then required to construct the next five items by reference to the designs illustrated on cards in red and white, as follows:



Of the five items in the test four require 4 blocks and one

requires 9 blocks. In the case of the first four only 4 bricks are scattered before the patient, and for the last item only 9.

13. The patient is asked to copy from 10 designs already constructed by the examiner, arrangements of orange-sticks in plasticine illustrated below.



Only in the first three designs are the sticks arranged in a single plane. In Design 4 the three sticks are arranged in planes at right angles to one another and in all the other designs the sticks are likewise arranged in different planes.

These 13 tests, though each simple, make, as a group, a variety of different demands upon the skill of the individual performing them.

(a) In Tests, 1, 2, 5, 6 7 and 8 the patient must use pencil on paper. In the other tests the patient has to manipulate other kinds of less familiar material (match-sticks, orange-sticks in plasticine, blocks, mannikin parts).

(b) In Tests 1, 2, 3 and 4 the patient is required to construct simple figures; simple in the sense that they are familiar (simple geometrical shapes) and that their nature could or can be communicated by a single word. The other tests contain figures for construction which are more complex in contrast to the above definition of simple.

(c) Tests 1, 3 and 8 require spontaneous construction by the subject, who has no current or immediate, recent reference to a model.

In Tests 2, 4, 5, 6, 10 and 13 the subject must copy from a model which is a replica of the design he is asked to produce. In Test 12 (Kohs') the patient has direct reference to a model which is not however a replica. In the remaining Tests 7 and 11 the subject must reproduce from a model which has been present but withdrawn immediately before construction begins.

(d) Certain tests consist of items which are all symmetrical to right and left of a central vertical axis or plane (1, 2, 3 and 4). The remaining tests contain some or all items which are asymmetrical in this way about a vertical axis.

(e) Tests 1 - 9 and 12 require a constructional design which is only two-dimensional. In Tests 10, 11, and 13 the design is three-dimensional in many of the items.

(f) In Tests 9 and 12 (Mannikin and Kohs') though the final surface design should be two-dimensional the patient is required to manipulate structural units through three-dimensional space to find an appropriate surface, as a preliminary but essential part of construction.

(g) Only Test 12 (Kohs') involves colour difference in design.

(h) Between tests and between items within tests, there is a wide variation between the number of units used in building or drawing. For example in Tests 10 and 11, Item 1 requires only 3 blocks for its construction and Item 3 requires 8: in Test 1 each item consists of only one simple geometrical shape, whereas in Test 5 each item consists of a collection of intersecting simple geometrical shapes, some of which are those encountered in Test 1. Some items therefore must require more time for their completion than others. No time limit however was imposed on subjects and testing was discontinued only when a response had

been made which satisfied the patient or where he refused or made no effort or said he did not know how to begin.

ASSOCIATED TESTING. The testing described above was not carried out in isolation. Not only were other special abilities investigated in some detail but so were many aspects of memory, temporal orientation and thinking. It was in this setting therefore that constructional apraxia was studied. Associated defect which seems to be relevant to the disability under study will be discussed when it is thought to be appropriate.

RESULTS.

Results will be considered at first discursively, test by test and at times in groups. Thereafter controls will be contrasted with the responses of the patients and if patients appear to differ among themselves, they will be compared with one another.

TESTS 1 and 2.

DRAWING SIMPLE GEOMETRICAL DESIGNS.

1. SPONTANEOUS
2. COPYING.

1. SPONTANEOUS DRAWING OF SIMPLE GEOMETRICAL FIGURES.

2. COPYING SIMPLE GEOMETRICAL FIGURES.

Figures 1 and 1c show all responses to these two tests by the 40 patients and 20 controls. These are now considered below.

PATIENTS. Table I gives detail of these responses expressed in terms primarily of "+" and "0" representing respectively satisfactory and unsatisfactory drawings. Other secondary symbols in this table will be explained shortly. The distribution of correct "+" responses is shown in Table II. These distributions are markedly different. High scores are much commoner in copying than in spontaneous drawing. Table III shows how frequently each figure is drawn correctly in the two tests. There is good correspondence between the two tests in the case of the first three geometrical figures (square, circle, cross) but spontaneous drawing of triangle and diamond are seen to be rarely drawn correctly. The character of responses and utterances made at the time of drawing suggests that patients are unfamiliar with the terms triangle and diamond as they refer to geometrical figures, and that this relative failure might represent a lifelong ignorance. If this were the case, the figures in Table II would not be strictly comparable. Table IV has therefore been devised to compare the distributions of correct response to the tests, when they have only three items each (square, circle and cross). Now the distributions are seen to be not dissimilar. In both tests high scores are commoner than low ones. At the simplest level therefore production of these figures under both

conditions of spontaneous drawing and copying is fairly accurately done.

PATIENTS' ERRORS. Responses, shown in Table I as "O" have been further classified thus, "G", "E" and "N". These symbols are now defined.

1. "G" refers to errors of gestalt, where a patient has made an effort to respond on paper but failed to draw the figure in any way resembling the required one, or where he has written or attempted to write the word describing the figure instead of the figure itself, or where he perseverates on a previous response or where he states explicitly that he has forgotten the figure required.

2. "E" refers to errors of execution, where a patient shows one or more of the following defects in response. Tremulousness, over-scoring or fragmentation of lines. Failure of lines to meet at angles, scribbling after the drawing is complete, omission of parts, rotation of the whole figure, unequal sides where equal sides are required, approximation of reproduction to model so that they touch or are quite superimposed. In other words in this type of error the idea of gestalt may be conveyed in the response, but its execution is accompanied by one of the faults just described.

3. "N" refers to errors which cannot be labelled as either "E" or "G". Patients who make responses of this kind either refuse to make any effort or persistently write their own name in response to all items or merely do not make any effort, though showing no sign of frank refusal. Errors of gestalt "G" and errors of execution "E" can according to these descriptions clearly occur in the same response.

Table V shows the frequency of these errors as they occur in each of the three figures (square, circle and cross) in both spontaneous drawing and copying. In the former test the number of "G" and "E" errors is roughly equal. In the latter, "E" outnumber "G" errors by four to one. "G" errors predominate in spontaneous drawing and "E" errors in copying. Table V shows also a difference in both tests between square and cross on the one hand and circle on the other with regard to their frequency of errors. In the circle errors are few.

The Diagram A demonstrates the type of errors made by individual patients in spontaneous drawing and the errors these patients made when they copy the same figure. The "+" symbol in this diagram indicates that all three items were correctly drawn. "G" and "E" indicate that the responses contain one or more "G" or "E" errors but no other type of error. "GE" indicates that the responses include both "G" and "E" errors. "N" indicates that none of the responses was a drawn or written one. This diagram is now described in detail.

<u>20 Patients</u> who make executive errors in copying consist of:

5 (Du, Ha, JM, AS, JK) who make no error at all in spontaneous drawing, and make "E" errors only in copying.

3 (HC, TN, Hc) who make "G" errors only in spontaneous drawing and "E" errors only in copying.

2 (M'G, BV) who make "G" errors only in spontaneous drawing and "GE" errors in copying.

These 10 patients demonstrate that they are capable of executive accuracy in conditions of spontaneous drawing but not in copying.

1 (JJ) who makes no response in spontaneous drawing makes "E" error only in copying.

5 (EC, MC, ML, Ri, FC) who make "E" errors only under both conditions.

2 (M'D, ER) who make "GE" errors in each test.

The last 9 patients referred to make executive errors under both conditions.

11 Patients who fail to portray the gestalt correctly ("G+GE") in spontaneous drawing consist of:

1 (Da) who makes a "G" error only in spontaneous drawing and no error in copying.

2 (M'D, ER) who make "GE" errors in spontaneous drawing and "E" errors only in copying.

1 (MM) who makes "GE" errors in spontaneous drawing and no error in copying.

These 7 patients demonstrate that they are capable of drawing an approximation of the correct gestalt under conditions of copying but not in spontaneous drawing.

2 (M'G, BV) who make "G" errors only in spontaneous drawing but "GE" errors in copying.

2 (TW, FA) who make "GE" errors in both tests.

The last 4 patients referred to make errors of gestalt under both conditions.

2 patients (AF, MW) make "G" errors only in copying. AF makes no error and MW makes no response in spontaneous drawing.

4 patients (MH, MK, M'Gi, MP) refuse in both conditions.

12 patients make no error in either condition.

Though triangle and diamond are perhaps not strictly comparable between the two conditions of spontaneous drawing and copying

for reasons that have been given, there is interest to be gained in comparing these figures when they are copied with the other (square, circle, cross) copied figures. Table VI gives detail of the number and type of error made in each of the five figures in copying. The totals in the bottom rank of this table suggest a hierarchy. Fewest errors are made when copying a circle, more are made in copying square and cross and most in copying triangle and diamond. When errors are examined by type, outright refusals remain constant in number irrespective of the figure copied and "G" errors follow most closely the hierarchy just mentioned. Only 1 error of gestalt is made in copying a circle, 3 each in copying square and cross, and 7 and 9 respectively in copying triangle and diamond.

When individual patient results are examined (Diagram B) only a slight shift is found in the number of patients making "E" errors, when copying square, circle and cross is compared with copying triangle and diamond. 3 patients now make executive errors under the latter condition, while 4 patients who previously made "E" errors when copying square, circle and cross do not do so when copying triangle and diamond. By contrast, 9 patients make errors of gestalt in copying the triangle and diamond who did not in copying the other figures, and in only 3 cases was the reverse so.

In total, the number of patients making executive errors remains constant while there is a marked increase (from 6 to 12) in those making gestalt errors in copying triangle and diamond compared with copying square, circle and cross.

SUMMARY OF PATIENT RESPONSES.

1. A large group of patients who are able to copy the two figures triangle and diamond are not able to draw these figures apontaneously.

2. The levels of correct scoring are otherwise high under both conditions of drawing.

3. The type of errors responsible for failure in the two tests tend to be different. Failure to portray the required gestalt predominates in spontaneous drawing and executive difficulty predominates in copying. A group of patients who are capable of executive accuracy in spontaneous drawing fail in this respect in copying. A group who successfully portray gestalt in conditions of direct copying, fail to do so in spontaneous drawing.

4. The levels of correct responses in the 5 figures is not uniform. Under both conditions the circle is drawn with fewer errors than square or cross, and in copying, square and cross have fewer errors than triangle and diamond. The larger number of errors in the latter pair of figures is mainly accounted for by an increase in errors of gestalt under conditions of copying.

CONTROLS. Table 1c is the control equivalent of Table 1 which detailed patients results. Table IIc shows the distribution of correct scores among the controls. These distributions are rather different though the difference is not of the same quality as that seen in patients. In this case spontaneous drawing is generally better performed than copying. This is also clearly seen when the results of only three figures (square,

circle and cross) are considered in Table IVc. Table IIIc shows the frequency of correctly drawn figures. Under both conditions the circle is most often correctly drawn and diamond least. In copying however the square is as infrequently drawn as diamond, and triangle is as often copied correctly as cross. The striking difference illustrated in Tables IIIc and III is that between the spontaneous drawing of triangle and diamond of the two groups. Controls do not show the very small number of correct responses achieved by patients when drawing these geometrical figures.

CONTROL ERRORS. These have been classified according to the same criteria as patient responses. A quick glance at Table Ic perhaps shows best the character of the errors in controls. There are 33 incorrect "O" responses. All but 9 of these are executive "E". In drawing of the first three figures (square, circle, cross) there are only executive errors: that is errors of gestalt "G" and errors designated "N" occur only in drawing triangle and diamond. Table Vc collects this information in respect of the first three figures which, as has been said, show only errors of execution.

Diagram Ac corresponds to Diagram A referring to patients. Individual subjects are viewed as they perform the two tests. 7 subjects among the controls (AB, JD, AG, MM, JP, SR, WW) show themselves to be capable of executive accuracy in conditions of spontaneous drawing but not in copying. 2 subjects (JB, M'L) show executive disturbance in both conditions, and 2 subjects (JC, RPo) failing in execution in spontaneous drawing, succeed in this respect when copying. The greatest shift in controls, therefore, is one which was also observed among patients:

namely the appearance under conditions of copying of executive errors in subjects who spontaneously draw the same design with executive accuracy. Table VIc shows the number and type of errors for all five figures copied by the control subjects. It demonstrates much the same trend as Table Vc where errors are exclusively executive. One error of gestalt does appear however in copying a triangle. In spontaneous drawing of these five geometrical figures controls make 3 "G" errors (in triangle and diamond) and 5 "N" errors (in triangle and diamond).

Comparing patients with controls therefore, there is a much greater difference between the frequency of "G" errors than "E" errors, irrespective of the conditions of drawing. The latter "E" are only twice as common in patients, whereas "G" errors are 8 - 12 times as common in patients than controls.

Diagram Bc referring to controls corresponds to Diagram B. for patients where copying square, circle and cross are compared with copying triangle and diamond. One can conclude little or nothing from it. It merely shows that the total number of subjects making executive errors remains constant (as in patients) while one subject made a gestalt error in the triangle-diamond group, whereas there was no such error in the other group.

SUMMARY OF CONTROL RESPONSES.

1. Among the controls there is not the very frequent failure to draw spontaneously triangle and diamond which was conspicuous among patients.

2. The levels of correct scoring are high.

3. The type of error responsible for failure is predominantly

executive. Errors of gestalt are rare and do not occur at all in the first three figures. In the other figures they are more frequent in spontaneous drawing than in copying. In controls a number of subjects who show themselves capable of executive accuracy in spontaneous drawing fail in that respect in copying.

4. The level of correct response in the five figures is not uniform. Under both conditions circle is most often, and diamond least often, drawn correctly.

PATIENT-CONTROL CONTRAST.

1. Correct scoring in controls is higher than in patients.

2. The difference in the level of performance is more largely accounted for by the difference between the occurrence of errors of gestalt in the two groups, than errors of execution.

3. Failure to draw spontaneously, triangle and diamond is much more conspicuous in patients than in controls.

4. There is similarity between certain individuals in both patients and controls who fail to achieve executive accuracy under conditions of copying but succeed in spontaneous drawing.

5. Both patient and control groups draw the circle correctly most often and diamond correctly least often.

FIGURE I

GEOMETRICAL FIGURES – SPONTANEOUS DRAWING

NAME	SQUARE	CIRCLE	CROSS	TRIANGLE	DIAMOND.
MA 1					Don't Know
FA 2					
Au 3					
FC 4					Don't Know
HC 5		Forget		Forget	Forget
EC 6					
Cu 7				Don't Know	Don't Know
Da 8				"CROSS"	"Diye"
Du 9				Don't Know	Don't Know
AF 10				Don't Know	Don't Know
Ha 11					
IH 12				Don't Know	Don't Know
He 13	Don't Know			Don't Know	Don't Know
MH 14	No Response	No Response	No Response	No Response	No Response

FIGURE I

GEOM. FIGS. — SPONT. DRAWING

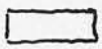
NAME	SQUARE	CIRCLE	CROSS	TRIANGLE	DIAMOND.
EJ. 15					
JJ. 16.		Don't know	Don't know	Don't know	Don't know
JK 17.					
MK 18	No Response	No Response	No Response	No Response	No Response
M'C 19				Don't Know	Don't Know
M'D 20					Don't Know
M'G 21				Don't Know	Don't Know
M'Gi 22	Writes own name	Writes own name	Writes own name	Writes own name	Writes own name
M'L 23					
M'N 24					
JM 25					
MM 26					
TN 27					

FIGURE I

GEOM. FIGS. — SPONT. DRAWING

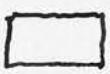
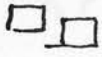
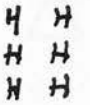
NAME	SQUARE	CIRCLE	CROSS	TRIANGLE	DIAMOND.
MP 29	Refuses	Refuses	Refuses	Refuses	Refuses
NP 29					
AP 30					
Ri 31					
ER 32					
Si 33					
ES 34					
AS 35					
ET 36					
BV 37	Tries to writ "square"	Tries to writ "square"	Tries to writ "square"	Tries to writ "square"	Tries to writ "square"
LV 38					
TW 39					
MW 40	Don't Know	Don't Know	Don't Know	Don't Know	Don't Know.

FIGURE I

GEOMETRICAL FIGURES — COPYING

NAME	SQUARE	CIRCLE	CROSS	TRIANGLE	DIAMOND.
MA 1					
FA 2					
Au 3					
FC 4					
HC 5					
EC 6					
Cu 7					
Da 8					
Du 9					
AF 10					
Ha 11					
IH 12					
He					
MH 14.	No Response	No Response	No Response	No Response	No Response.

FIGURE I

GEOM. FIGS. — COPYING.

Name	SQUARE	Circle	Cross	Triangle	Diamond
EJ 15					
JJ 16					
JK 17					
MK 18	No Response	No Response	No Response	No Response	No Response
M'C 19	 attached to model.				
M'D 20					
M'G 21					
M'Gi 22	Writes own name	Writes own name	Writes own name	Writes own name	Writes own name
M'L 23					
M'N 24					
JM 25					
MM 26					
TN 27		adds to the model	adds to the model.		adds to the model.

FIGURE I

GEOM. FIGS. – COPY.

NAME	SQUARE	CIRCLE	CROSS	TRIANGLE	DIAMOND.
MP 28	Refuses	Refuses	Refuses	Refuses	Refuses.
WP 29					
AP 30					
Ri 31					
ER 32					
Si 33					
ES 34					
AS 35					
ET 36					
BV 37	Tries to write "SQUARE"		superimposed on model.	adds to model.	Adds to model.
LV 38					
TW 39					
MW 40					

TABLE I

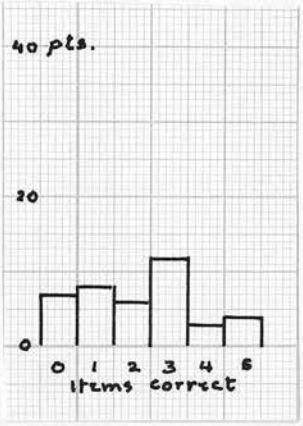
	SPONTANEOUS □	○	+	△	◇	COPYING □	○	+	△	◇
1	+	+	+			+	+	+	+	+
2	+	+					+	+	+	+
3	+	+	+	+		+	+	+	+	+
4			+				+	+		
5	+		+			+	+			
6		+					+	+		
7	+	+	+			+	+	+	+	
8	+					+	+	+		+
9	+	+	+				+		+	
10	+	+	+							
11	+	+	+			+	+		+	+
12	+	+	+			+	+	+	+	+
13		+	+				+		+	
14										
15	+	+	+	+	+	+	+	+	+	+
16						+	+			
17	+	+	+	+			+		+	
18										
19		+	+				+	+		
20		+					+			
21			+					+		
22										
23		+					+	+		
24	+	+	+			+	+	+	+	+
25	+	+	+			+	+			
26	+			+		+	+	+	+	+
27		+								
28										
29	+	+	+	+	+	+	+	+	+	+
30	+	+	+	+	+	+	+	+	+	+
31		+	+		+	+	+		+	+
32		+		+			+	+	+	+
33	+	+	+	+		+	+	+	+	+
34	+	+	+			+	+	+	+	+
35	+	+	+							
36	+	+	+			+	+	+		+
37							+			
38	+	+	+	+	+	+	+	+	+	+
39		+					+			
40						+	+			

TABLE II

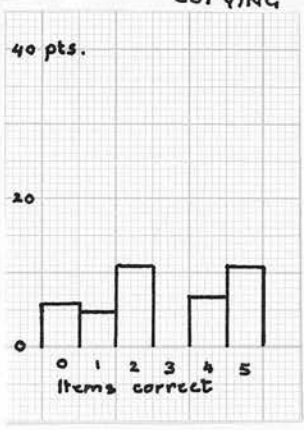
DISTRIBUTION OF CORRECT RESPONSES

No. of correct responses	No. of pts.	
	Spont.	Copy.
5	4	11
4	3	7
3	12	0
2	6	11
1	8	5
0	7	6

SPONTANEOUS



COPYING



COPYING

TABLE III

FREQUENCY OF CORRECT SCORES BY DESIGN.

Test.	Design				
	□	○	+	△	◇
Spontaneous	22	28	24	8	5
Copying	20	33	21	19	17

TABLE IV

DISTRIBUTION OF CORRECT RESPONSES (□○+)

No. of correct responses	No. of pts.	
	Spont.	copy.
3	18	14
2	5	12
1	10	8
0	7	6

TABLE V

ERRORS

ERROR	Spontaneous				Copying			
	□	○	+	TOTAL	□	○	+	TOTAL
G	4	4	8	16	3	1	3	7
E	8	2	4	14	14	2	13	29
N	6	6	6	18	4	4	4	12
Total	18	12	18		21	7	20	

DIAGRAM A

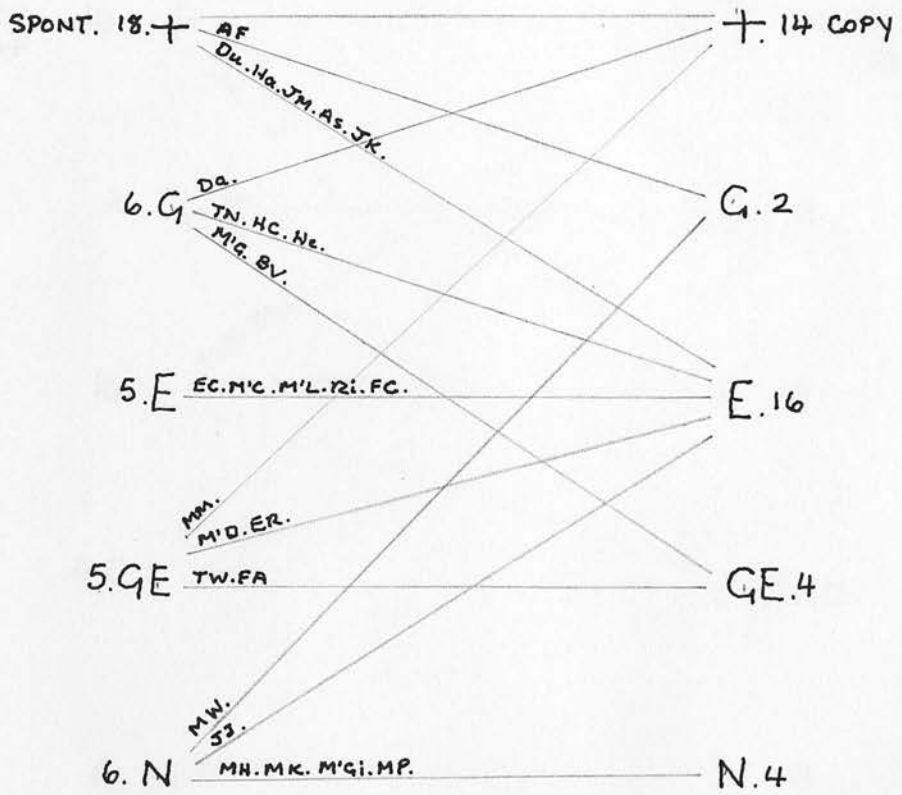


TABLE VI
ERRORS

Error	Spontaneous						Copying					
	□	○	+	△	◇	Total	□	○	+	△	◇	Total
G	4	4	8	13	18	47	3	1	3	7	9	23
E	8	2	4	5	10	29	14	2	13	15	17	61
N	6	6	6	15	14	47	4	4	4	4	4	20
Total	18	12	18	33	42		21	7	20	26	30	

DIAGRAM B.

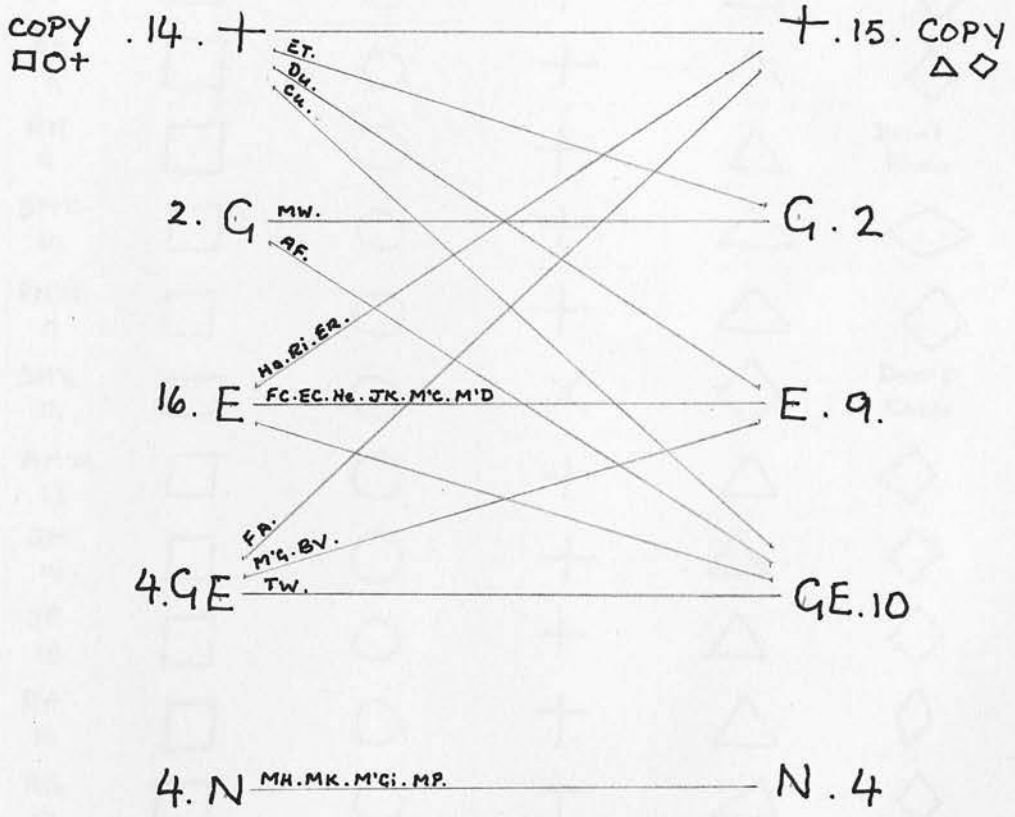


FIGURE I^{c}

GEOMETRICAL FIGURES — SPONTANEOUS DRAWING.

NAME	SQUARE	CIRCLE	CROSS	TRIANGLE	DIAMOND
JB 1					
AB 2				Don't Know	
BC 3					
JC 4				Don't Know	
JD 5					
JE 6					
SF 7					
AG 8					
RH 9					Don't Know
SM'C 10					
PM'K 11					
SM'L 12					Don't Know
AM'M 13					
JM 14					
JP 15					
RP 16					
RP$_{a}$ 17					
AR 18					
SR 19					Don't Know
WW 20					

FIGURE Ic

GEOMETRICAL FIGURES – COPYING.

NAME	SQUARE	CIRCLE	CROSS	TRIANGLE	DIAMOND.
JB 1					
AB 2					
BC 3					
JC 4					
JD 5					
JE 6					
SF 7					
AG 8					
RH 9					
SM'C 10					
PM'K 11					
SM'L 12					
AM'M 13					
JM 14					
JP 15					
RP 16					
RPo 17					
AR 18					
SR 19					
WW 20					

TABLE I[c]

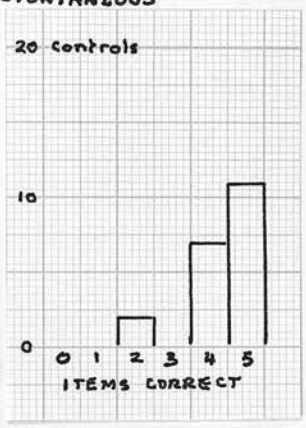
	SPONTANEOUS					COPYING				
	□	○	+	△	◇	□	○	+	△	◇
1	O[E]	+	+	+	+	O[E]	+	O[E]	+	+
2	+	+	+	O[N]	+	O[E]	+	+	+	+
3	+	+	+	+	+	+	+	+	+	+
4	+	+	O[E]	O[N]	O[C],O[E]	+	+	+	O[E]	O[E]
5	+	+	+	+	+	O[E]	+	+	+	O[E]
6	+	+	+	+	+	+	+	+	+	+
7	+	+	+	+	+	+	+	+	+	+
8	+	+	+	O[C]	+	O[E]	+	+	+	O[E]
9	+	+	+	+	O[N]	+	+	+	+	O[E]
10	+	+	+	+	+	+	+	+	+	+
11	+	+	+	+	+	+	+	+	+	O[E]
12	O[E]	+	+	O[C]	O[N]	+	+	O[E]	+	+
13	+	+	+	+	O[E]	O[E]	+	+	+	+
14	+	+	+	+	+	+	+	+	O[E]	+
15	+	+	+	+	+	O[E]	+	+	+	+
16	+	+	+	+	+	+	+	+	+	O[E]
17	O[E]	+	+	+	+	+	+	+	+	+
18	+	+	+	+	+	+	+	+	+	+
19	+	+	+	+	O[N]	+	+	O[E]	O[C]	+
20	+	+	+	+	+	O[E]	+	+	+	+

TABLE II[c]

DISTRIBUTION OF CORRECT RESPONSES

No. of correct responses	No. of controls	
	spont.	copy.
5	11	6
4	7	9
3	0	5
2	2	0
1	0	0
0	0	0

SPONTANEOUS



COPYING

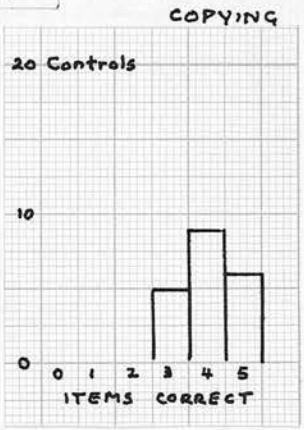


TABLE III[c]

FREQUENCY OF CORRECT SCORES BY DESIGN

Test	Design				
	□	○	+	△	◇
Spontaneous	17	20	19	16	15
Copying	13	20	17	17	13

TABLE IV[c]

DISTRIBUTION OF CORRECT RESPONSES (□○+)

No. of correct responses	No. of controls	
	spont.	copy
3	16	11
2	4	8
1	0	1
0	0	0

TABLE $\overline{V}^{c}$
ERRORS

ERROR	Spontaneous				Copying			
	□	O	+	TOTAL	□	O	+	TOTAL
G	-	-	-	-	-	-	-	-
E	3	-	1	4	7	-	3	10
N	-	-	-	-	-	-	-	-
TOTAL	3	-	1		7	-	3	

DIAGRAM A^{c}

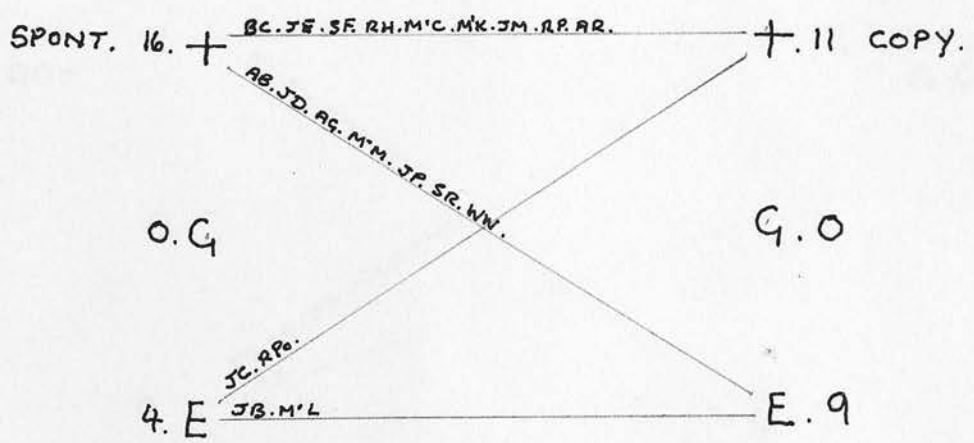
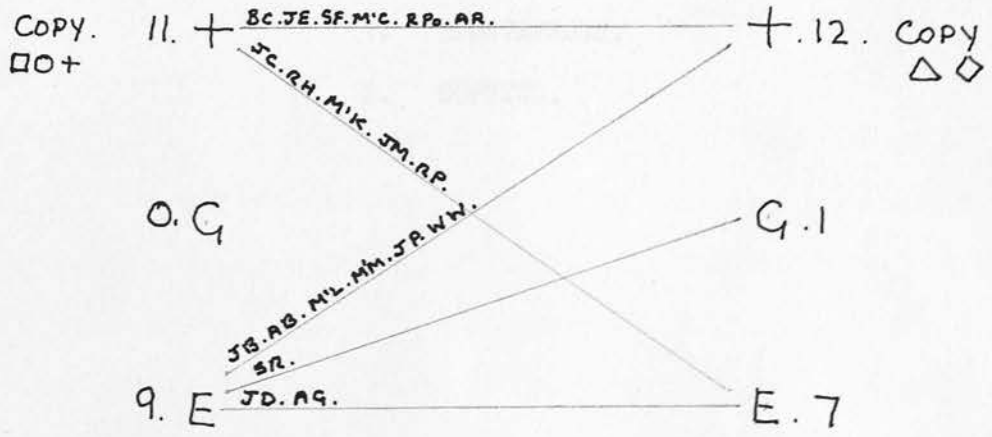


TABLE VI c

ERRORS

ERROR	Spontaneous						Copying					
	□	○	+	△	◇	TOTAL	□	○	+	△	◇	TOTAL
G	–	–	–	2	1	3	–	–	–	1	–	1
E	3	–	1	–	2	6	7	–	3	2	6	18
N	–	–	–	2	3	5	–	–	–	–	–	–
Total	3	–	1	4	6		7	–	3	3	6	

DIAGRAM Bc



O.GE

GE.O

O.N

N.O

TESTS 3 and 4.

CONSTRUCTING MATCHSTICK DESIGNS.

1. SPONTANEOUS.
2. COPYING.

3. SPONTANEOUS CONSTRUCTION OF SIMPLE GEOMETRICAL FIGURES WITH MATCHSTICKS.

4. COPYING SIMPLE GEOMETRICAL FIGURES WITH MATCHSTICKS.

Figures 1 and 1c show all patient and control responses to these two tests.

PATIENTS. Table 1 symbolises these responses in the way described above in drawing geometrical figures. Table 11 shows the distribution of correct "+" responses in the two tests. Because there is the same doubt about the triangle in these tests as in the first two tests considered Table 111 has been devised to consider responses to square and cross only. Both Tables 11 and 111 show that compared with other constructional tests the level of correct response is high. In spontaneous construction half the patients give correct responses (Table 111) and in direct copying three-quarters give correct responses. Table 1V which shows the frequency with which each figure is drawn correctly, shows good correspondence between the two tests. Success with these designs occurs in the same order under both conditions; viz. square is most often correctly constructed, triangle least often and cross occupies an intermediate position. The frequency of correct responses in conditions of spontaneous construction in the case of the triangle is seen to be especially low. This seems to correspond with the striking rate of failure described above, in drawing triangle and diamond under similar conditions.

PATIENT ERRORS. Incorrect responses "0" shown in Table 1 have been further classified as "G", "E" and "N". These symbols must be defined again in the new circumstances of matchstick construction.

1. "G" refers to errors of gestalt; i.e. where the design is

not recognisable as such in the patient's responses.

2. "E" refers to errors of execution, where a patient shows one or more of the following responses. Failure of matches to meet at angles, omission of a match, rotation of the whole figure, distortion of angles, approximation of reproduction to model and laying the matches in rows. In this error the idea of gestalt may be conveyed but execution is faulty in one of the ways just listed.

3. "N" refers to errors which cannot be described in terms of "G" or "E". If the patient constructs one or two of the items correctly, but refuses the remaining items, then these refusals have been labelled "GE".

Table V shows the frequency of these errors as they occur in each of the three figures (square, cross, triangle) under the two conditions of construction. In the spontaneous task the number of "G" and "E" errors is roughly equal; in copying, "G" errors are diminished by one half while "E" errors remain constant. This table shows also that errors are most frequent in triangle and least in the square. Comparing spontaneous construction with copying in Table V by reference to the right hand column in each block, which shows totals considering square and cross only, "E" errors occur with much the same frequency in both conditions, while "G" errors occur twice as often in spontaneous construction as in copying.

Diagram A compares the two conditions of matchstick construction considering all three figures. In summary it demonstrates a shift away from "G" errors between the spontaneous and copying tasks. There are no other major changes and in particular no sign of an increase in "E" errors in direct copying.

Diagram B makes the same kind of comparison but excludes

consideration of the triangle. The same trends are manifest as in Diagram A though less conspicuously.

SUMMARY OF PATIENT RESPONSES.

1. A large group of patients able to copy the triangle are unable to construct it spontaneously.

2. The levels of scoring are otherwise high, but higher in copying than in spontaneous construction.

3. The type of errors responsible for failure in the two tests tend to be different. Failure to portray the required gestalt predominates in spontaneous construction. There is no similar dominance of executive errors in direct copying.

4. The levels of correct response among the three figures is not uniform. Under both conditions square shows fewest errors and triangle most. The cross occupies an intermediate position.

CONTROLS. Table 1c is the control equivalent of Table 1 which referred to patient results. Without further analysis it is sufficient to say after a quick glance at this table that the responses are almost perfect. One error only appears in each test and their significance is therefore beyond comment.

SUMMARY OF CONTROL RESPONSES.

1. There is no failure to construct a triangle spontaneously.

2. Correct scoring is almost perfect.

3. Errors are so few that their significance cannot be discussed.

PATIENT-CONTROL CONTRAST.

1. Correct scoring in controls is much higher than in patients.

2. Controls do not show any significant failure in constructing

a triangle spontaneously; a failure conspicuously common in patients.

FIGURE I

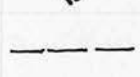
NAME	MATCHSTICK DESIGNS — SPONTANEOUS CONSTRUCTION			MATCHSTICK DESIGNS — COPYING		
	SQUARE	CROSS	TRIANGLE	SQUARE	CROSS	TRIANGLE
MA 1						
FA 2	Refuses	Refuses	Refuses	Refuses	Refuses	Refuses
Au 3						
FC 4						
HC 5		No response	No response		Adds to model	
EC 6						
Cu 7						
Da 8						
Du 9						
AF 10			No response			
Ha 11						
IH 12						
He 13			No response			
MH 14			No response			No response
EJ 15						
JJ 16						
JK 17						
MK 18			No response	Adds to model	No response	No response
M'C 19			No response			
M'D 20						

FIGURE I

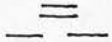
NAME	MATCHSTICKS - SPONTANEOUS			MATCHSTICKS - COPYING.		
	SQUARE	CROSS	TRIANGLE	SQUARE	CROSS	TRIANGLE
M'G 21						
M'G; 22	Don't know	Don't Know	Don't Know	Adds to model		counts sticks
M'L 23						
M'N 24						
JM 25						
MM 26						
TN 27	No response	No response	No response			
MP 28			Don't Know			
WP 29						
AP 30						
RL 31						
ER 32						
Si 33			"2 Triangles"			
ES 34						
AS 35						
ET 36						
BV 37		No response	No response		adds to model	adds to model
LV 38						
TW 39						
MW 40		No response	No response		adds to model	

TABLE I

	SPONTANEOUS			COPYING		
	□	+	△	□	+	△
1	+	+	+	+	+	+
2	○	○	○	○	○	○
3	+	+	○	+	+	+
4	+	○	○	+	+	○
5	+	○	○	○	○	○
6	+	+	○	+	+	+
7	+	+	○	+	+	+
8	○	○	○	+	+	+
9	+	+	○	+	+	+
10	+	+	○	+	+	+
11	+	+	○	+	+	+
12	+	+	+	+	+	+
13	+	○	○	+	+	+
14	○	+	○	+	+	○
15	+	+	+	+	+	+
16	○	+	○	+	+	+
17	+	+	○	+	+	+
18	+	○	○	○	○	○
19	○	+	○	+	○	○
20	+	○	○	+	+	+
21	+	○	○	+	○	○
22	○	○	○	○	○	○
23	+	+	○	+	+	○
24	+	+	○	+	+	+
25	+	+	+	+	+	+
26	○	+	○	+	+	+
27	○	○	○	○	○	○
28	○	○	○	+	+	○
29	+	+	+	+	+	+
30	+	+	+	+	+	+
31	+	+	+	+	+	+
32	+	+	+	+	+	+
33	+	+	○	+	+	+
34	+	+	+	+	+	+
35	○	+	○	+	+	+
36	+	+	+	+	+	+
37	+	○	○	+	○	○
38	+	+	+	+	+	+
39	+	○	○	+	○	+
40	+	○	○	+	○	○

TABLE II

DISTRIBUTION OF CORRECT RESPONSES

No. of correct responses	No. of pts.	
	spont.	copy
3	11	26
2	10	5
1	14	4
0	5	5

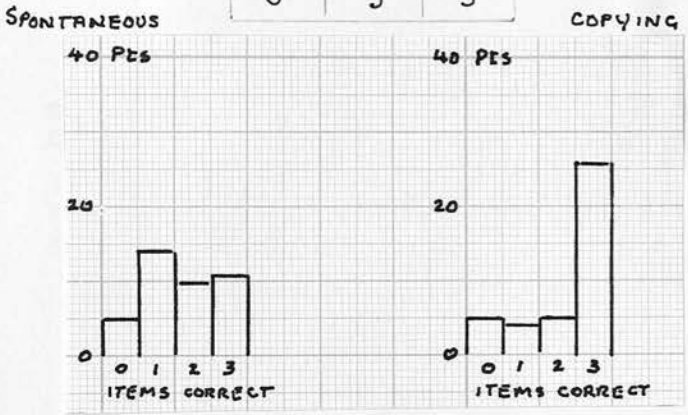


TABLE III

DISTRIBUTION OF CORRECT RESPONSES (□+)

No. of correct responses	No. of pts.	
	spont.	Copy.
2	21	30
1	14	5
0	5	5

TABLE IV

FREQUENCY OF CORRECT SCORES BY DESIGN

Test	Design		
	□	+	△
Spontaneous	30	26	11
Copying	35	30	27

TABLE V
ERRORS

Error	Spontaneous				Copying			
	□	+	△	□+	□	+	△	□+
G	3	10	(25)	13	1	5	(9)	6
E	5	7	(11)	12	4	7	(8)	11
N	3	3	(3)	6	1	1	(1)	2
Total	11	20	(39)		6	13	(18)	

DIAGRAM A

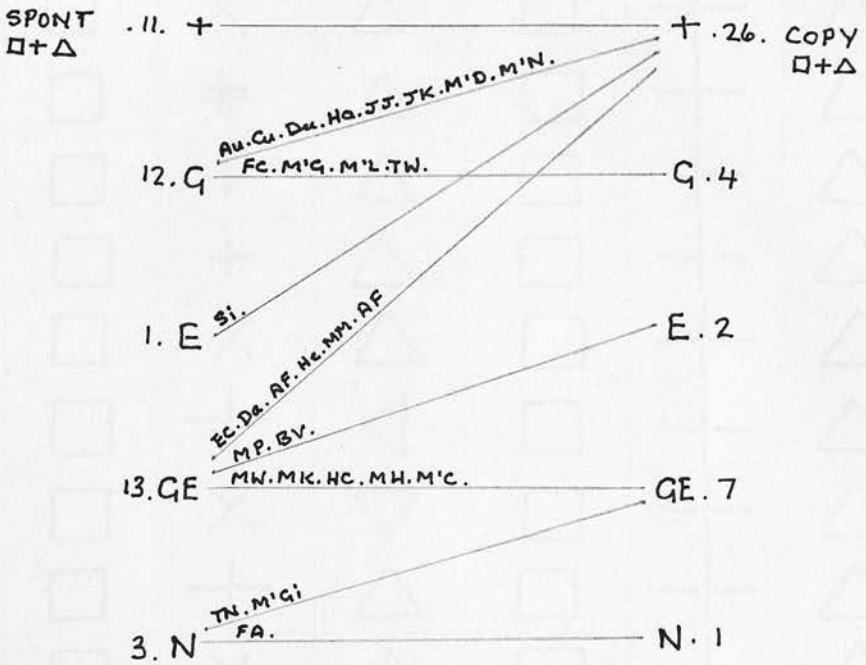


DIAGRAM B

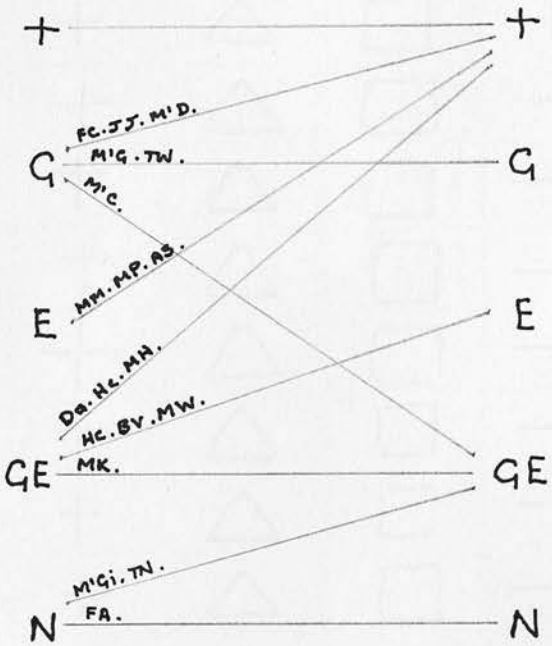


FIGURE I^c

	MATCHSTICK DESIGNS — SPONTANEOUS CONSTRUCTION			MATCHSTICK DESIGNS — COPYING		
NAME	SQUARE	CROSS	TRIANGLE	SQUARE	CROSS	TRIANGLE
JB 1						
AB 2						
BC 3						
J'C 4						
JD 5						
JE 6						
SF 7						
AG 8						
RH 9						
SM'C 10						
PM'K 11						
SM'L 12						
AM'M 13						
JM 14						
JP 15						
RP 16						
RP0 17						
AR 18						
SR 19						
WW 20						

TABLE I^{C}

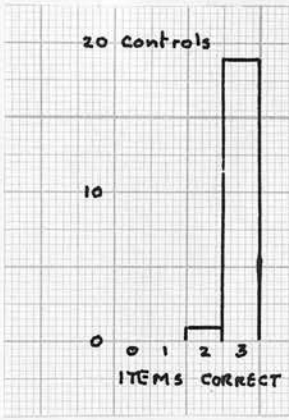
	SPONTANEOUS			COPYING		
	□	+	△	□	+	△
1	+	+	O_{C}	+	+	+
2	+	+	+	+	+	+
3	+	+	+	+	+	+
4	+	+	+	+	+	+
5	+	+	+	+	+	+
6	+	+	+	+	+	+
7	+	+	+	+	+	+
8	+	+	+	+	+	+
9	+	+	+	+	+	+
10	+	+	+	+	+	+
11	+	+	+	+	+	+
12	+	+	+	+	+	+
13	+	+	+	+	O_{E}	+
14	+	+	+	+	+	+
15	+	+	+	+	+	+
16	+	+	+	+	+	+
17	+	+	+	+	+	+
18	+	+	+	+	+	+
19	+	+	+	+	+	+
20	+	+	+	+	+	+

TABLE II[c]

DISTRIBUTION OF CORRECT RESPONSES

No. of correct responses	No. of pts	
	spont.	copy.
3	19	19
2	1	1
1	0	0
0	0	0

SPONTANEOUS



COPYING

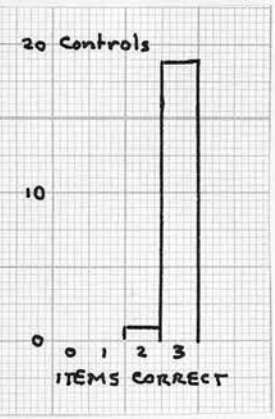


TABLE III[c]

DISTRIBUTION OF CORRECT RESPONSES (□+)

No. of correct responses	No. of controls	
	spont.	copy
2	20	19
1	0	1
0	0	0

TABLE IV[c]

FREQUENCY OF CORRECT SCORES BY DESIGN

Test	Design		
	□	+	△
Spontaneous	20	20	19
Copying	20	19	20

TABLE $\overline{V}^{c}$
ERRORS

ERROR	spontaneous				copying			
	□	+	△	TOTAL	□	+	△	TOTAL
G	–	–	1	1	–	–	–	–
E	–	–	–	–	–	1	–	1
N	–	–	–	–	–	–	–	–
TOTAL	–	–	1		–	1	–	

TEST 5.

COPYING ABELSON'S FIGURES.

5. COPYING ABELSON'S FIGURES.

Figures 1 and 1c show all the drawn responses to this test by patients and controls. Figures 2 and 2C show responses to that part of the test where the subject must describe the simple geometrical shapes which go to make up the whole form.

PATIENTS. Table 1 gives detail of responses to both parts of the test. (a) lists "+" and "0" responses to the naming task. (b) lists "+" and "0" responses to the copying part of the test. Correct naming has been judged rather liberally where the designs contain a triangle on the assumption that the name of this shape is not generally known. A response has been scored "+" therefore, not only when all the shapes of a figure have been correctly identified by name, but also where all the shapes but the triangle have been named, and where naming the triangle has been omitted.

Table 11 shows the distribution of correct "+" responses. Copying is poorly performed. No patient draws all 5 figures quite correctly, and 25 fail to draw any correctly. Correct identification of shapes, on the other hand, is performed with much greater frequency. 8 patients name the shapes in all 5 figures correctly, while only 5 fail to name any figure correctly.

Table 111 shows the frequency with which each figure is drawn and named correctly. The table suggests that the designs fall into three groups, determined by correct score size. Figures 1 and 2 are named and copied correctly by most, Figure 5 by fewest, and Figures 3 and 4 occupy an intermediate position in this respect. This kind of rating corresponds to the numbers of simple geometrical figures which go to make up the larger designs; i.e. Figures 1 and 2 have only two shapes, Figures 3 and 4 have three, and Figure 5 has four.

PATIENT ERRORS. Incorrect responses "O" have been further classified as "G", "E" and "N". These symbols will be defined again as they refer to faulty performance in the circumstances of copying and naming Abelson's figures.

COPYING.

1. "G" refers to an error of gestalt whereby the design presented on the model card is not recognisable as such in the patient's response. In detail defects of this kind include those listed where "G" is defined in drawing geometrical figures, together with two additional defects, viz. omission of the whole of one of the component units of a design e.g. where the diamond of Design 1 is omitted, and where dissociation of the component parts of the whole design occurs so that it can no longer be viewed as the composite whole it ought to be.

2. "E" refers to errors of execution, where one of the following defects is seen in response. Those defects listed under "E" in drawing simple geometrical figures together with an additional one; namely, rotation of one component figure of the whole upon the rest of the design, e.g. rotation of the diamond in Design 1 so that it tends to appear in square orientation.

3. "N" refers to a verbal refusal or complete lack of response or a statement by the patient to the effect that he does not know how to proceed.

"G" and "E" errors may occur together in the same response.

NAMING.

1. "G" refers to a response where one or more but not all of the shapes comprising a design has been misidentified or omitted, or where more component shapes than in fact there are, have been named.

2. "N" refers to a response where the patient has refused, or made no effort to respond.

Table 1V shows the frequency of errors just defined as they occur in each of the five designs. "E" errors "GE and E" are markedly more frequent in the more complex designs (3 - 5) than in the simpler ones (1 - 2). Refusals increase in frequency with complexity. Table V, where the designs are grouped according to the number of component geometrical shapes each contains, shows this trend more clearly.

Table V1 gives detail of how each patient responds to each of the five items of the test with regard to both naming component shapes and copying total designs. This table in fact combines the information in the two parts of Table 1. As there are 3 possible responses to naming "+" "G" and "N" and 5 possible responses to copying "+" "G" "E" "GE" "N" there are therefore 15 possible combined responses. The evaluation of this table will be considered in terms of errors of gestalt "G"."+" and "E" responses will be considered as "Non-G"."G" "GE" and "N" are considered as "G". The numbers in the right-hand column of the table (e.g. 4/3) refer to the ratio between the number of "Non-G" responses in naming and the number of "Non-G" responses in copying. Four types of combined response are thus possible.

1. High scores in both naming and copying. (e.g. 5/4).
2. High scores in naming and low in copying. (e.g. 5/1).
3. Low score in naming and high score in copying. (e.g. 2/5).
4. Low scores in both naming and copying. (e.g. 2/1).

High and low have been arbitrarily fixed: 4 and 5 are regarded as high: 0 - 3 as low scoring. This allows a patient only 1 "G" "GE" or "N" error in a high score. To make labelling less cumbersome the four categories just described are called:

1. "Non-G" (of whom there are 7 patients).

2. "+G" (of whom there are 13 patients).

3. "G +" (of whom there is 1 patient).

4. "G" (of whom there are 19 patients).

The patients' error types in these terms are listed alongside Table V1. Thus the "Non-G" group are capable of perceiving and naming all the individual geometrical shapes in each design and drawing these designs in a form resembling the one presented on the model card. The "+G" group succeed in perceiving the shapes but generally fail to draw the designs in a form resembling the model. The "G+" group, which consists of only one patient, fails to perceive the shapes but succeeds in drawing the designs. JJ does this however only by following the lines on the card with his pencil. The manner of his execution is at fault, but whether he would be truly able to reproduce the gestalt correctly more remotely from the model, is in doubt.

The fourth group "G" are neither able to perceive adequately the individual shapes or draw the design in a form resembling the model.

The single patient in the third group "G+" will not be considered further. The constructional efforts of the remaining groups are now compared. Table V11 gives detail of responses to direct copying in the three groups. The totals in the right hand column of each group have been expressed in percentages for the purpose of comparison. The trends are as follows: Correct responses "+" and executive errors "E" are most frequent (over 90% of all responses) in patients classified as "Non-G". In the "+G" group correct responses and executive errors constitute 35% of all responses. In the "G" group they are only 14% of responses.

The remaining errors "G" "GE" and "N" are insignificant in the "Non-G" group. Errors of gestalt "G" are more common among patients of the "G" than the "+G" group. Combined errors are more common in the "+G" than in the "G" group. The reverse is true of refusals "N" but together "GE and N" are roughly equal in the two groups.

Table V111 considers the three groups "Non-G" "+G" and "G" again, in order to show the effect of complexity upon the character of the responses. The numbers are expressed in percentages for comparison. In all three groups the number of correct responses diminishes as the complexity of the figure they have to copy increases. Executive errors "E" increase with increasing complexity in the "Non-G" group. In the other two groups executive errors diminish, but combined errors "GE" and refusals "N" increase with increasing complexity of design.

The effect of increasing complexity upon the frequency of errors of gestalt "G" differs between the two groups "+G" and "G". In the "+G" group these errors are more frequent as complexity increases. In the "G" group they remain roughly constant despite complexity of design.

SUMMARY OF PATIENT RESPONSES.

1. The constructional part of this test is poorly performed. More than half the patients fail to copy any of the designs correctly, and no patient copies all correctly.

2. Perception of the individual shapes comprising the designs is carried out with a good degree of accuracy. More than half the patients succeed in naming the shapes in at least 4 of the 5 designs.

3. When the group is considered as a whole, executive errors "GE and E" remain constant irrespective of the complexity of the design.

Errors of gestalt "GE and G" are more common in the more complex designs.

4. 39 of the 40 patients fall into three groups.

(1) Those who succeed in both the constructional and perceptual parts of the test.

(2) Those who succeed in the perceptual part but fail in the constructional part.

(3) Those who fail in both parts.

5. Errors of gestalt are most common in the last of these groups but their frequency remains constant irrespective of the complexity of the designs copied. Errors of gestalt are less common in the second group, but these errors increase in frequency as design increases in complexity.

CONTROLS. Table 1c gives detail of responses by controls to both parts of the test. (a) deals with copying and (b) with naming. It can be seen at a glance that naming is carried out without error by all 20 subjects.

Table 11c shows the distribution of correct responses. The contrast between naming and copying is striking. On the same criteria used to score copying in patients, the controls achieve scores rather higher on the whole but the level is still low. For example no control copies all five designs correctly. Only one subject however failed all five designs.

Table 111c shows how frequently each figure is copied and named correctly. Naming is quite correct as pointed out above. The five designs again show signs of falling into groups, judging by their frequency of correct drawing. Thus Designs 1 and 2 are most often, and Design 5 least often copied correctly. Designs 3 and 4 occupy an

intermediate position.

CONTROL ERRORS. Table 1Vc shows the frequency of the kind of errors defined in the section dealing with patient errors in Abelson's figures. "E" errors can be seen to account almost wholly for failure. Where "G" errors occur at all, they do so most often in respect of the fifth design, i.e. the most complex design. There are no refusals. Table Vc, where designs are grouped according to the number of component geometrical shapes each contains, tends to show a gentle increase in the frequency of "E" errors as complexity increases.

Table V1c gives the same detail for controls which Table V1 does for patients. All 20 subjects, by this manoeuvre, fall into the category of high scoring, in both naming and copying, i.e. "Non-G". They are all capable of perceiving and naming the individual component shapes in a design and copying these designs in a form resembling those presented on the model card.

Because the error type among controls is invariably the same ("Non-G") tables corresponding to Tables V11 and V111 devised for patients are not necessary. Table Vc can be compared with the "Non-G" block of Table V111. Both show a falling number of correct responses, and an increasing number of "E" errors as complexity increases.

SUMMARY OF CONTROL RESPONSES.

1. The constructional part of the test is performed rather poorly. No subject copied all five designs correctly.

2. Perception and naming of individual shapes is carried out by all subjects without error.

3. When the group of controls is considered as a whole, executive errors show a tendency to increase in frequency as complexity increases. Errors of gestalt are rare and tend to occur in the most

complex design only.

4. All subjects belong to a class which succeeds in both the constructional and perceptual parts of the task.

PATIENT-CONTROL CONTRAST.

1. Performance in both parts of the test is on the whole better in controls than in patients. The raw scores of correct results among controls are nevertheless poor in copying.

2. In the analysis of errors there is a striking difference in the character of the errors causing failure. Errors of gestalt are rare in the control group and very common among patients.

3. The two groups are similar in showing errors of gestalt most prominently in the most complex design. Though the effect of increasing complexity on executive errors differs between the two groups. On the whole these errors remain constant in patients but tend to increase in frequency in controls.

4. The control group differs from the patient group in having all its subjects in the one "Non-G" error-type category. The feature common to this category, in both patients and controls, is that executive errors tend to increase in frequency as complexity increases.

FIGURE I

ABELSON'S FIGURES - Copying

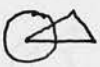
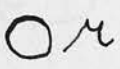
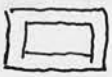
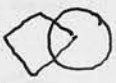
NAME	1	2	3	4	5
MA 1					
FA 2				Refuses	Refuses
Au 3					
FC 4		No response	No response	No response	No response
HC 5					
EC 6					
Cu 7					
Da 8					
Du 9					
AF 10					
Ho 11					
IH 12					
He 13					
MH 14	No response	No response	No response	No response	No response

FIGURE I

ABELSON'S FIGS.

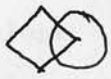
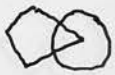
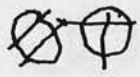
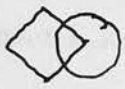
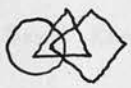
NAME	1	2	3	4	5
EJ 15					
JJ 16	Tries to follow card design	Tries to follow card design	Tries to follow card design	Tries to follow card design	Tries to follow card design
JK 17					
MK 18	No response	No response	No response	No response	No response
M'C 19					
M'D 20					
M'G 21					
M'Gi 22	Writes own name	Writes own name	Refuses	Refuses	Refuses
M'L 23					
M'N 24					
JM 25					
MM 26					
TN 27			Tries to draw on card	Tries to draw on card	Tries to draw on card

FIGURE I

ABELSON'S FIGS.

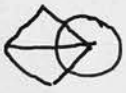
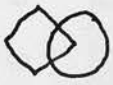
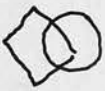
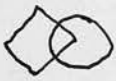
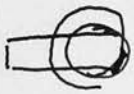
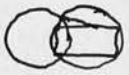
NAME	1	2	3	4	5
MP 28	Refuses	Refuses	Refuses	Refuses	Refuses
NP 29					
AP 30					
Ri 31					
ER 32					
Si 33					
BS 34					
AS 35				Don't know	Don't know
ET 36					
BV 37	Don't know	Don't Know	Don't Know	Don't know	Don't know
LV 38					
TW 39					
MW 40					Don't know

FIGURE 2

ABELSON'S FIGURES — VERBAL IDENTIFICATION OF SHAPES.

NAME	1	2	3	4	5
MA 1					
FA 2					Don't Know
Au 3					
FC 4		No response	No response	No response	No response
HC 5					
EC 6					
Cu 7					
Da 8					?
Du 9					
AF 10					
Wa 11		point		point	peak
IH 12					
He 13					
MH 14	No response	No response	No response	No response	No response
EJ 15					
JJ 16					
JK 17			envelope		
MK 18	No response	No response	No response	No response	No response
M'C 19					
M'D 20					

SYMBOLS

Square
Circle
Triangle
Diamond
Semicircle
Cross
Oval

FIGURE 2

ABELSON'S FIGS. — IDENTIFICATION.

NAME	1	2	3	4	5
M'G 21					stroke
M'Gi 22	No response	No response	No response	No response	No response
M'L 23		 stick			
M'N 24				Semisquare	Semisquare
JM 25	apple		 ½ Heart		
MM 26					
TN 27	Don't Know	Don't Know	Don't Know	Don't Know	Don't Know
MP 28	Refuses	Refuses	Refuses	Refuses	Refuses
NP 29					
AP 30					
Ri 31					
ER 32		Dagger			
Si 33		Don't Know	Don't Know	Don't Know	
ES 34					
AS 35		Kite	Kite Envelope		
ET 36					
BV 37					
LV 38					
TW 39					
MN 40		Don't Know	Don't Know	Don't Know	Don't Know

TABLE I

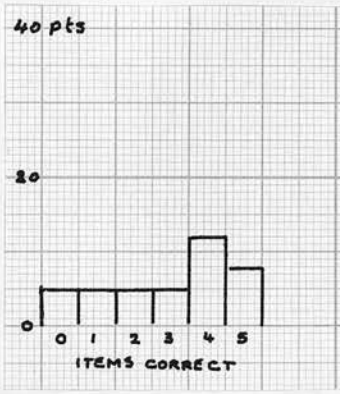
	a) NAMING 1	2	3	4	5	b) COPYING 1	2	3	4	5
1	+	+	+	+	+	+	+	+	+	+
2	+	+	+	+	+	+	+	+	+	+
3	+	+	+	+	+	+	+	+	+	+
4	+	+	+	+	+	+	+	+	+	+
5	+	+	+	+	+	+	+	+	+	+
6	+	+	+	+	+	+	+	+	+	+
7	+	+	+	+	+	+	+	+	+	+
8	+	+	+	+	+	+	+	+	+	+
9	+	+	+	+	+	+	+	+	+	+
10	+	+	+	+	+	+	+	+	+	+
11	+	+	+	+	+	+	+	+	+	+
12	+	+	+	+	+	+	+	+	+	+
13	+	+	+	+	+	+	+	+	+	+
14	+	+	+	+	+	+	+	+	+	+
15	+	+	+	+	+	+	+	+	+	+
16	+	+	+	+	+	+	+	+	+	+
17	+	+	+	+	+	+	+	+	+	+
18	+	+	+	+	+	+	+	+	+	+
19	+	+	+	+	+	+	+	+	+	+
20	+	+	+	+	+	+	+	+	+	+
21	+	+	+	+	+	+	+	+	+	+
22	+	+	+	+	+	+	+	+	+	+
23	+	+	+	+	+	+	+	+	+	+
24	+	+	+	+	+	+	+	+	+	+
25	+	+	+	+	+	+	+	+	+	+
26	+	+	+	+	+	+	+	+	+	+
27	+	+	+	+	+	+	+	+	+	+
28	+	+	+	+	+	+	+	+	+	+
29	+	+	+	+	+	+	+	+	+	+
30	+	+	+	+	+	+	+	+	+	+
31	+	+	+	+	+	+	+	+	+	+
32	+	+	+	+	+	+	+	+	+	+
33	+	+	+	+	+	+	+	+	+	+
34	+	+	+	+	+	+	+	+	+	+
35	+	+	+	+	+	+	+	+	+	+
36	+	+	+	+	+	+	+	+	+	+
37	+	+	+	+	+	+	+	+	+	+
38	+	+	+	+	+	+	+	+	+	+
39	+	+	+	+	+	+	+	+	+	+
40	+	+	+	+	+	+	+	+	+	+

TABLE II

DISTRIBUTION OF CORRECT RESPONSE

No. of correct responses	No. of pts.	
	Naming	copy
5	8	0
4	12	1
3	5	1
2	5	2
1	5	11
0	5	25

NAMING



COPYING

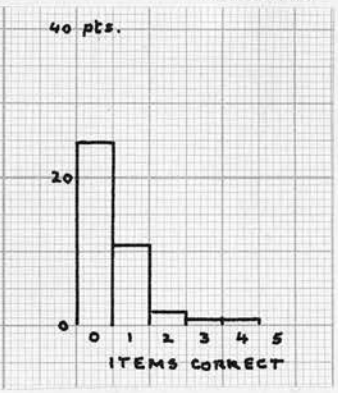


TABLE III

FREQUENCY OF CORRECT SCORES BY DESIGN.

Test	Design				
	1	2	3	4	5
Naming	29	29	22	24	13
Copying	8	10	2	2	0

TABLE IV

ERRORS

Error	Design				
	1	2	3	4	5
correct	8	10	2	2	0
G	9	8	8	14	14
E	13	14	9	7	8
GE	6	3	15	9	9
N	4	5	6	8	9

TABLE V
ERRORS

Error	Design		
	1 & 2	3 & 4	5
Correct	9	2	0
G (GE + G)	13	23	23
E (GE + E)	18	20	17
N	4·5	7	9

TABLE VI – see next page.

TABLE VII
ERRORS

NON G

Response	Design					
	1	2	3	4	5	TOTAL
+	4	4	2	2	–	34·3
G	–	–	–	–	1	2·9
E	3	3	5	3	6	57·1
GE	–	–	–	2	–	5·7
N	–	–	–	–	–	–

+ G

Response	Design					
	1	2	3	4	5	TOTAL
+	3	3	–	–	–	8·6
G	1	2	1	5	6	21·4
E	8	7	2	2	–	27·1
GE	2	2	11	6	7	40·0
N	–	–	–	1	1	2·8

G

Response	Design					
	1	2	3	4	5	TOTAL
+	1	2	–	–	–	3·3
G	8	5	7	8	6	37·8
E	2	5	1	1	1	11·1
GE	3	1	4	2	3	14·4
N	4	5	6	7	8	33·3

TABLE VIII
ERRORS

NON G

Response	Design		
	1 & 2	3 & 4	5
+	57·1	28·6	–
G	–	–	14·3
E	42·9	57·1	85·7
GE	–	14·3	–
N	–	–	–

+ G

Response	Design		
	1 & 2	3 & 4	5
+	21·4	–	–
G	10·7	21·4	42·9
E	53·6	14·3	–
GE	14·9	60·7	50·0
N	–	3·6	7·1

G

Response	Design		
	1 & 2	3 & 4	5
+	8·3	–	–
G	36·1	41·7	33·3
E	19·4	5·6	5·6
GE	11·1	16·7	16·7
N	25·0	36·1	44·4

TABLE VI

	FIGURE 1	2	3	4	5	CORRECT NAMING SCORE '+' or 'E' COPYING SCORE	ERROR TYPE
1	+	+	+	+	+	5/4	Non G
	+	E	E	GE	E		
2	G	+	G	+	N	2/2	G
	E	E	G	N	N		
3	+	+	+	G	+	4/3	+ G
	E	+	E	GE	G		
4	+	+	G	+	G	3/0	G
	G	N	N	N	N		
5	G	+	+	G	G	2/0	G
	G	G	G	G	G		
6	+	+	+	+	G	4/1	+ G
	E	G	GE	G	G		
7	+	+	G	+	G	3/1	G
	G	+	G	G	G		
8	+	+	+	+	N	4/1	+ G
	G	E	G	G	G		
9	+	+	+	+	+	5/3	+ G
	+	E	G	E	G		
10	G	+	G	+	G	2/0	G
	GE	GE	G	G	GE		
11	+	+	+	+	G	4/2	+ G
	E	+	GE	G	G		
12	+	+	+	+	G	4/5	Non G
	E	+	E	E	E		
13	G	+	G	G	G	1/1	G
	G	E	GE	G	G		
14	N	N	N	N	N	0/0	G
	N	N	N	N	N		
15	+	G	+	+	+	4/5	Non G
	E	E	E	+	E		
16	G	+	G	G	G	1/5	G +
	E	E	E	E	E		
17	+	+	G	+	+	4/2	+ G
	E	E	GE	GE	G		
18	N	N	N	N	N	0/0	G
	N	N	N	N	N		
19	+	G	+	G	G	2/0	G
	G	G	G	G	G		
20	+	+	G	+	G	3/1	G
	GE	E	GE	GE	G		
21	+	+	+	+	G	4/0	+ G
	GE	G	GE	GE	GE		
22	N	N	N	N	N	0/0	G
	G	G	N	N	N		
23	+	+	+	G	+	4/0	+ G
	GE	GE	GE	GE	GE		
24	+	G	+	+	+	4/4	Non G
	+	+	+	E	G		
25	G	+	G	G	G	1/1	G
	G	E	GE	G	G		
26	+	+	G	G	G	2/2	G
	E	E	GE	GE	GE		
27	N	N	N	N	N	0/3	G
	GE	G	E	E	E		
28	N	N	N	N	N	0/0	G
	N	N	N	N	N		
29	+	+	+	+	G	4/3	+ G
	E	E	E	G	GE		
30	+	+	+	+	+	5/5	Non G
	+	+	+	+	E		
31	+	+	+	+	+	5/4	Non G
	E	E	E	GE	E		
32	+	+	+	+	G	4/2	+ G
	E	+	GE	G	GE		
33	+	N	N	N	G	1/2	G
	+	E	GE	GE	GE		
34	+	+	+	+	+	5/2	+ G
	+	E	GE	GE	GE		
35	+	+	+	+	+	5/1	+ G
	E	GE	GE	N	N		
36	+	+	+	+	+	5/3	+ G
	+	+	GE	E	GE		
37	+	G	+	+	G	3/0	G
	N	N	N	N	N		
38	+	+	+	+	+	5/5	Non G
	+	+	E	E	E		
39	+	+	G	+	G	3/2	G
	E	+	G	G	GE		
40	+	N	N	N	N	1/0	G
	G	G	G	G	N		

FIGURE I^c

ABELSON'S FIGURES — COPYING

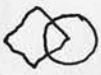
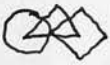
NAME	1	2	3	4	5
JB 1					
AB 2					
BC 3					
JC 4					
JD 5					
JE 6					
SF 7					
AG 8					
RH 9					
SM'C 10					
PM'K 11					
SM'L 12					
AM'M 13					
JM 14					
JP 15					
RP 16					
RPo 17					
AR 18					
SR 19					
WW 20					

FIGURE 2c

ABELSON'S FIGURES — VERBAL IDENTIFICATION OF SHAPES

NAME	1	2	3	4	5
JB 1					
AB 2					
BC 3					
JC 4					
JD 5					
JE 6					
SF 7					
AG 8					
RH 9					
SM'C 10					
SM'K 11					
SM'L 12					
AM'M 13					
JM 14					
JP 15					
RP 16					
RP0 17					
AR 18					
SR 19					
WW 20					

SYMBOLS

CIRCLE ○
SQUARE □
DIAMOND ◇
TRIANGLE △

TABLE I^{c}

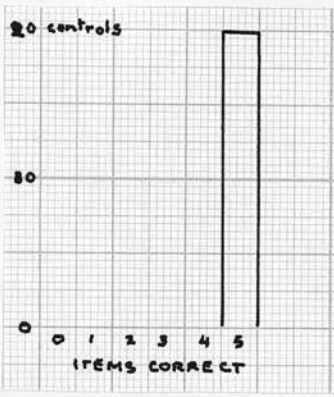
	a) NAMING 1 2 3 4 5	b) COPYING 1	2	3	4	5
1		+	+			
2					+	
3		+				
4		+		+		
5			+	+		
6		+		+		+
7		+				
8		+				
9	ALL	+	+	+		
10	CORRECT		+	+		
11				+	+	+
12		+	+			
13		+	+			
14			+			
15		+	+	+	+	
16			+			
17		+	+			
18		+	+	+	+	
19						
20		+	+	+	+	

TABLE II^c

DISTRIBUTION OF CORRECT RESPONSES

No. of correct responses	No. of controls	
	Naming	Copy.
5	20	–
4	–	3
3	–	3
2	–	7
1	–	6
0	–	1

NAMING



COPYING

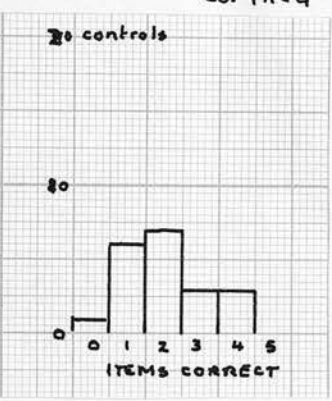


TABLE III^c

FREQUENCY OF CORRECT SCORES BY DESIGN

Test	Design				
	1	2	3	4	5
Naming	20	20	20	20	20
Copying	13	12	9	5	2

TABLE IV^c

ERRORS

ERROR	Design				
	1	2	3	4	5
correct	13	12	9	5	2
G	1	–	–	–	1
E	6	8	11	15	13
GE	–	–	–	–	4
N	–	–	–	–	–

TABLE V[c]
ERRORS

ERROR	Design		
	1 & 2	3 & 4	5
Correct	12·5	7	2
G (GE & G)	0·5	—	5
E (GE & E)	7	13	17
N	—	—	—

TABLE VI[c]

	FIGURE 1	2	3	4	5	CORRECT NAMING SCORE '+' or 'E' COPYING SCORE	ERROR TYPE
1	+	+	+	+	+	5/5	Non G
	+	+	E	E	E		
2	+	+	+	+	+	5/5	"
	E	E	E	+	E		
3	+	+	+	+	+	5/5	"
	+	E	E	E	E		
4	+	+	+	+	+	5/5	"
	+	E	+	E	E		
5	+	+	+	+	+	5/4	"
	E	+	+	+	G		
6	+	+	+	+	+	5/5	"
	+	E	+	E	+		
7	+	+	+	+	+	5/5	"
	+	E	E	E	E		
8	+	+	+	+	+	5/4	"
	+	E	E	E	GE		
9	+	+	+	+	+	5/5	"
	+	+	+	E	E		
10	+	+	+	+	+	5/5	"
	E	+	+	E	E		
11	+	+	+	+	+	5/5	"
	E	E	+	+	+		
12	+	+	+	+	+	5/5	"
	+	+	E	E	E		
13	+	+	+	+	+	5/5	"
	+	+	E	E	E		
14	+	+	+	+	+	5/4	"
	G	+	E	E	E		
15	+	+	+	+	+	5/5	"
	+	+	+	+	E		
16	+	+	+	+	+	5/4	"
	E	+	E	E	GE		
17	+	+	+	+	+	5/4	"
	+	+	E	E	GE		
18	+	+	+	+	+	5/5	"
	+	+	+	+	E		
19	+	+	+	+	+	5/4	"
	E	E	E	E	GE		
20	+	+	+	+	+	5/5	"
	+	+	+	+	E		

TESTS 6 AND 7.

DRAWING BENDER-GESTALT FIGURES.

1. COPYING.

2. REPRODUCTION FROM IMMEDIATE MEMORY.

6. COPYING BENDER-GESTALT FIGURES.

7. REPRODUCTION OF BENDER-GESTALT FIGURES FROM IMMEDIATE MEMORY.

Figures 1 and 1c show the responses to these two tests by patients and controls.

PATIENTS. Table 1 gives detail of responses to direct copying in terms of "+" and "0" already defined. Table 11 shows side by side the responses to Items A and 8 of the Bender-Gestalt designs performed from immediate memoryand by direct copying. Table 111 gives the distribution of correct responses to the whole test under conditions of copying. No patient copies all designs correctly and 20 patients fail to copy any figure correctly. This test as a whole clearly presents great difficulty.

A quick glance at Table 11 shows that correct responses "+" are rare. 5 patients only copy both designs correctly, and no patient reproduces both correctly from immediate memory.

PATIENT ERRORS. Incorrect responses, shown in Tables 1 and 11 as "0" have been further classified as "G" "E" and "N". These will be defined again.

1. "G" refers to errors of gestalt. Defects of this kind include those listed where "G" is defined in copying Abelson's figures.

2. "E" refers to errors of execution. Defects of this kind include those listed where "E" is defined in copying Abelson's figures, wit the addition of completion of unclosed figures. (Designs 4 and 5).

3. "N" refers to refusals, etc.

Table 1V shows the frequency of these errors (and correct responses) as they occur in copying all 9 designs. Designs 1, 2 and 3 are most often incorrectly drawn. In the last two ranks of Table 1V the number of responses containing errors of gestalt "G" and those containing no

error of gestalt "Non-G" are shown. Designs 1, 2 and 3 are more often copied with errors of gestalt than the other designs and the ratio of "G" to "Non-G" in these three designs is markedly different from this ratio in the other six designs where it is strikingly constant.

Table V shows individual patient performance for all eight designs. Column (a) shows the number of errors made of each type. Column (b) represents a summary whereby each patient is classified as showing predominantly correct "+" responses, or predominantly errors of gestalt "G", executive errors "E", combined errors "GE", or no response "O". These summaries have been compiled by reference not only to the numbers in column (a) but also by reference back to the drawn material (Figure 1). Thus two patients who copied 6 and 7 out of 9 designs correctly, made errors in the remaining figures which showed minimal executive defect. The whole performance in these cases was classified as "+". Where patients have made outstanding errors of gestalt, even though accompanied by executive errors of a minor degree, the whole response has been classified as "G". Where executive errors are outstanding the response is called "E". Where both types of error occur severely and neither is clearly dominant, then the whole response is classified as "GE". The numbers of patients making each type of response, just defined, appears at the foot of column (b).

Table V1 shows the frequency of errors "G" "E" and "N" as they occur in the two Designs A and 8 under conditions of direct copying and reproduction from immediate memory. The totals in the bottom rank show that there is little or no difference between the two designs in the order of difficulty they present in any one condition of drawing. This is also true of each individual type of error. When the results of copying are compared with reproduction from immediate memory, "G" errors in the latter

grossly out-number "G" errors in the former, whereas the reverse is true for "E" errors. In reproduction from immediate memory "G" out-number "E" errors by 2 to 1. In copying "E" out-number "G" errors by a somewhat lower ratio.

Diagram A shows individual patient responses under the two conditions of copying and reproduction from immediate memory of the two Designs A and 8.

28 patients who made executive errors in copying "E" and "GE" consist of:-

7 (Cu, M'D, M'N, TW, Du, MM, Si) who make "G" errors only in reproduction from immediate memory and "E" errors only in copying.

3 (Da, BV, MW) who make "G" errors only in reproduction from immediate memory and "GE" errors in direct copying.

These 10 patients demonstrate that they are capable of executive accuracy under conditions of reproduction from immediate memory but not in direct copying.

2 (EJ, ET) make "E" errors only under both conditions.

5 (MA, EC, IH, LV, ER) make both types of error in reproduction from immediate memory but "E" errors only in copying.

9 (FC, HC, AF, M'C, ML, JM, WP, AS, Hc.) make both types of error under both conditions.

These 16 patients make executive errors under both conditions.

2 (JJ, TN) make no response in reproduction from immediate memory and both types of error in direct copying.

30 patients who fail to portray the gestalt correctly "G" and "GE" in reproduction from immediate memory consist of:-

3 (JK, AP, Au.) make "G" errors only in reproduction from immediate memory and no error in copying.

7 (Cu, M'D, M'N, TW, Du, MM, Si.) make "G" errors only in reproduction from immediate memory and no error in copying.

1 (Ha) makes "GE" errors in reproduction from immediate memory and no error in copying.

5 (MA, EC, IH, LV, ER) make "GE" errors in reproduction from immediate memory and "E" errors only in copying.

These 16 patients demonstrate that they are capable of drawing an approximation of the correct gestalt under conditions of direct copying but not in reproduction from immediate memory.

2 (M'G, ES) make "G" errors only in both conditions.

3 (Da, BV, MW) make "G" errors only in reproduction from immediate memory and both types of error in copying.

9 (FC, HC, AF, M'C, ML, JM, WP, AS, Hc) make both types of error in both conditions.

These 14 patients make errors of gestalt in both conditions.

5 patients (FA, MH, MK, M'Gi, MP) refuse under both conditions.

The conditions of drawing are different in Diagram A but the complexity of the designs is the same. 16 patients who make errors of gestalt in reproduction from immediate memory do not in copying. 10 patients who make executive errors in copying do not in reproduction from immediate memory.

Diagram B shows a comparison in circumstances where the conditions are the same (copying) but the complexity of the designs is different. In one test, square, circle and cross are copied; in the other Items A and 8 of the Bender-Gestalt are copied. The diagram shows that as the designs become more complex the number of combined "GE" errors increases. It may be incidentally noticed that there is no corresponding increase in pure errors of gestalt "G" with this greater complexity. This supports

the earlier observation that this error is less common in conditions of direct copying.

Diagram C compares conditions that are similar (viz. drawing, where no model is present to copy from) but where the complexity of the figures is different. The two tests involved here are spontaneous drawing of square, circle and cross and the reproduction from immediate memory of Items A and 8 of the Bender-Gestalt. Again combined "GE" errors are more frequent where the designs are more complex. In this comparison, in contrast to that in Diagram B, errors of gestalt "G" are more frequent where complexity is greater. This tends to confirm the earlier observation that these errors "G" are more frequent in conditions of spontaneous drawing.

Diagram D compares all the simple geometrical figures with all the Bender-Gestalt designs the results of whose copying was summarised on pages **86-87** . The compared designs thus vary in complexity but the conditions are the same, viz. copying. The number of patients showing both "G" and "E" errors increases where the designs are more complex. The pattern of change is very similar to that shown in Diagram B where the comparison is also one between the same conditions (copying) but of designs different in complexity.

Reviewing the comparisons just made in these diagrams where various parts and the whole of the tests involving the copying, spontaneous drawing and reproduction from immediate memory of simple geometrical and Bender-Gestalt designs are examined. The following comments may be made.

1. Where conditions vary from drawing without a model in one test to direct copying in the other, but the designs presented for drawing in each test are the same. In these circumstances executive

errors are more frequent in copying (among patients who achieve executive accuracy in conditions of spontaneous drawing) and errors of gestalt more frequent in drawing without a model than in direct copying.

2. Where conditions of drawing are the same (copying) but the designs presented for drawing are different in complexity. In these circumstances combined "GE" errors are more frequent where the designs are more complex. Diagrams of this type show that there is a shift towards "E" errors among those patients who performed the simpler task correctly. At the same time other patients making combined "GE" errors in the more complex task were those who in the simpler task made "E" errors only. In other words, whereas complexity contributes to pure "E" from "+" it takes away from pure "E" to "GE".

3. Where conditions of drawing are the same (Drawing without a model present) but the designs presented for drawing are different in complexit In these circumstances combined "GE" errors are more frequent where the figures are more complex. Pure "G" errors also increase with increased complexity in conditions where no model is present.

SUMMARY OF PATIENT RESPONSES TO BENDER-GESTALT TEST.

1. The level of correct scoring is low. No patient draws all 9 designs correctly, and 20 patients fail to draw any figure correctly.

2. In reproduction from immediate memory errors of gestalt mainly account for failure. In direct copying executive errors are mainly responsible. A group of patients demonstrate that they are capable of executive accuracy under conditions of reproduction from immediate memory but not in copying.

3. When designs are more complex, as in the Bender-Gestalt test, patients are more likely to draw them with both errors of gestalt and execution.

4. Designs which have numerous components and those which require "completion" for the perception of their total gestalt tend to evoke more errors of gestalt in copying than designs which are relatively more "closed".

5. Spontaneous drawing (i.e. where a model has never been present) and reproduction from immediate memory (i.e. where a model is presented but withdrawn before response begins) evoke the same pattern of incorrect responses.

CONTROLS. Tables 1c and 11c give details of responses to direct copying of all nine designs, and responses to Items A and 8 only, under the two conditions of direct copying and reproduction from immediate memory. Table 111c gives the distribution of correct responses to the whole test under conditions of copying. No control subject copies all nine designs correctly, but only one subject fails tocopy any design correctly, and the number of high scores (5 - 9/9) is nearly half the group, whereas only one tenth of the patient group achieve this level.

Table 111c (i) shows side by side the distributions of correct scores in that part of the test comparing copying and reproduction from immediate memory of Items A and 8. The raw scores of correct results are not dis-similar. Copying is rather better performed on the whole than reproduction from immediate memory.

CONTROL ERRORS. Table 1Vc shows the frequency of the kind of errors defined in the section dealing with patient errors in Bender-Gestalt designs. "E" errors can be seen to account almost wholly for failure. "G" errors are rare. There are no refusals.

Table Vc corresponds to, and was devised in the same way as Table V which referred to patient errors. It can be seen at a glance that all

20 subjects fall into only two error type groups; viz. "+" and "E".

Table V1c shows the frequency of errors as they occur in the two Designs A and 8 under conditions of direct copying and reproduction from immediate memory. The totals in the bottom rank show that there is no difference between the two designs in the order of difficulty they present in reproduction from immediate memory, though there are more errors in A than in 8 in copying. When copying is compared with reproduction from immediate memory "G" errors in the latter greatly out-number "G" errors in the former, whereas "E" errors are constant. In bothconditions "E" errors are more frequent than "G" errors.

Diagram Ac shows individual control responses under two conditions of copying and reproduction from immediate memory of the Designs A and 8. Of 14 subjects who made executive errors in copying "E and GE" we find:-

1. 2 (AB, M'L) who are capable of executive accuracy under conditions of reproduction from immediate memory.

2. 12 who make executive errors under both conditions.

Of 9 subjects who fail to portray the gestalt correctly "G and GE" in reproduction from immediate memory:-

1. 7 can draw an approximation of the correct gestalt when copying

2. 2 make errors of gestalt under both conditions.

Diagram Bc compares circumstances where the conditions are the same (copying) but the complexity of the designs is different, and corresponds to a similar one for patients. The diagram shows that as the designs become more complex there is only a trivial increase in the number of combined "GE" errors.

Diagram Cc compares circumstances where the conditions are similar, (drawing where no model is present to copy from) but where the complexity of the designs is different. This diagram corresponds to a

similar one for patients. It can be seen here that as complexity increases, combined "GE" errors become more frequent but the increase in "G" errors is trivial.

Diagram Dc compares all the simple geometrical figures with all the Bender-Gestalt designs the results of whose copying was summarised on Table Vc. The designs compared vary in complexity but the conditions are the same; viz. copying. The diagram shows no great change in the frequency of "G" or "E" errors irrespective of the complexity of the design.

Reviewing the comparisons just made in these diagrams.

1. Where conditions vary from drawing without a model to direct copying, and where the designs presented for copying are the same, errors of gestalt are more frequent where no model is present. In contrast to patient performance there is no marked increase in the frequency of executive errors in copying.

2. Where conditions of drawing are the same (copying) but the designs presented for drawing are different, there is only a trivial increase in combined "GE" errors. Among these control subjects, complexity contributes to pure "E" from "+" but it does not take away from pure "E" to "GE".

3. Where conditions of drawing are the same (drawing without a model present) but the designs presented for drawing are different in complexity, combined "GE" errors are more frequent where complexity is greater. There is no great increase however in "G" errors with greater complexity.

SUMMARY OF CONTROL RESPONSES.

1. The level of correct scoring is low. No subject draws all 9 designs correctly, but only one subject fails to draw any design correctly.

2. In both copying and reproduction from immediate memory errors of execution mainly account for failure. Though errors of gestalt are less frequent under both conditions, they form a larger proportion of all errors in reproduction from immediate memory than in copying.

3. When designs are more complex, as in the Bender-Gestalt test, control subjects do not draw them with more errors of execution or gestalt

4. There is no sign that any design or group of designs within the Bender-Gestalt series evokes more errors of gestalt in copying than any other.

PATIENT-CONTROL CONTRAST.

1. Half the controls but only one tenth of the patients achieve high scores in copying.

2. The disproportion between patients and controls in reproduction from immediate memory is much greater.

3. In copying, "G" errors are a prominent cause of failure in patients but are almost non-existent in controls.

4. Designs 1, 2 and 3 are distinguished by the difficulty they present to patients in copying. No such difficulty is seen to occur in controls.

5. In both patient and control groups "G" errors are more common in reproduction from immediate memory, than they are in copying. "E" errors are more common in copying than in reproduction from immediate memory among patients, but there is no noticeable difference among controls. The control series does not show up a group which, while capable of executive accuracy in conditions of reproduction from immediate memory fail in conditions of copying. There is such a group in the patient series.

6. When design becomes more complex in copying, patients make more combined "GE" and executive "E" errors, but controls do not.

When design becomes more complex, where drawing occurs without a model from which to copy, both patients and controls make more combined "GE" errors. In these circumstances, however, patients make many more errors of gestalt "G" whereas controls do not.

FIGURE I

BENDER-GESTALT — COPYING

NAME	A	1	2	3	4	5	6	7	8
MA 1									
FA 2	Refuses	Refuses	Refuses	Refuses	Refuses	Refuses	Refuses	Refuses	Refuses
Au 3									
FC 4		To end of page	To end of page				To end of page		
HC 5		To end of page							
EC 6									
Cu 7									
Da 8		To end of page	To end of page						
Du 9									
AF 10									

FIGURE I

BENDER-GESTALT - COPYING.

NAME	A	1	2	3	4	5	6	7	8
Ha 11									
IH 12									
He 13		1,00,100,00 10000		1,000,0000		12345			
MH 14	Refuses	Refuses	Refuses	Refuses	Refuses	Refuses	Refuses	Refuses	Refuses
EJ 15		1222221							
JJ 16		TRIES TO DRAW ON THE MODEL							
JK 17									
MK 18	Refuses	Refuses	Refuses	Refuses	Refuses	Refuses	Refuses	Refuses	Refuses
M'C 19									
M'D 20									

FIGURE 1

BENDER - GESTALT - COPYING.

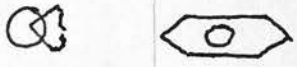
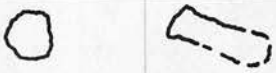
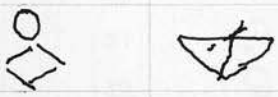
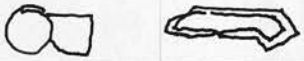
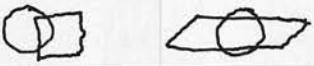
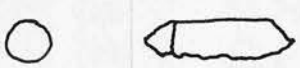
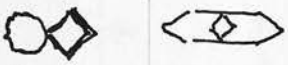
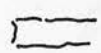
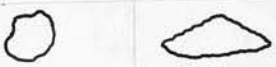
NAME	A	1	2	3	4	5	6	7	8
MG 21									
MGi 22	Writes name	Writes Name	Writes name	Writes Name	Writes Name	Writes name	Writes name	Writes name	Writes name
ML 23									
MN 24									
JM 25									
MM 26									
TN 27			Refuses	Refuses	Refuses	Refuses	Refuses	Refuses	Refuses
MP 28	Refuses	Refuses	Refuses	Refuses	Refuses	Refuses	Refuses	Refuses	Refuse
NP 29									
AP 30									

FIGURE 1

BENDER - GESTALT - COPYING

FIGURE 1

BENDER-GESTALT
REPRODUCTION FROM IMMEDIATE MEMORY

NAME	A	8
MA 1		
FA 2	Refuses	Refuses
Au 3		
FC 4		
HC 5		
EC 6		
Cu 7		
Da 8		
Du 9		
AF 10		
Wa 11		
JH 12		
He 13		
MH 14	Refuses	Refuses
EJ 15		
JJ 16	Don't Know	Don't Know
JK 17		
MK 18	Refuses	Refuses
M'C 19	Forget	
M'D 20		

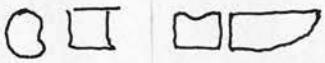
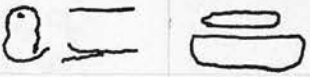
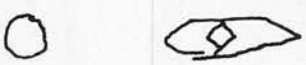
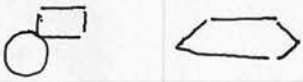
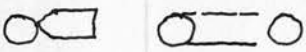
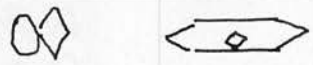
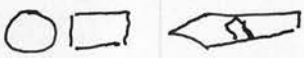
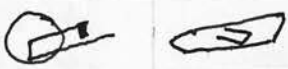
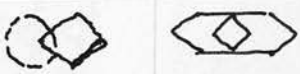
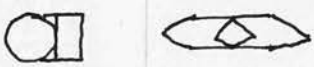
NAME	A	8
M'G 21		
M'Gi 22	Don't Know	Don't Know
M'L 23		
M'N 24		
JM 25		
MM 26		
TN 27	Don't Know	Don't Know
MP 28	Refuses	Refuses
WP 29		
AP 30		
Ri 31		
ER 32		
Si 33		
ES 34		
AS 35		
ET 36		
BV 37		
LV 38		
TW 39		Forget
MW 40		Forget

TABLE I

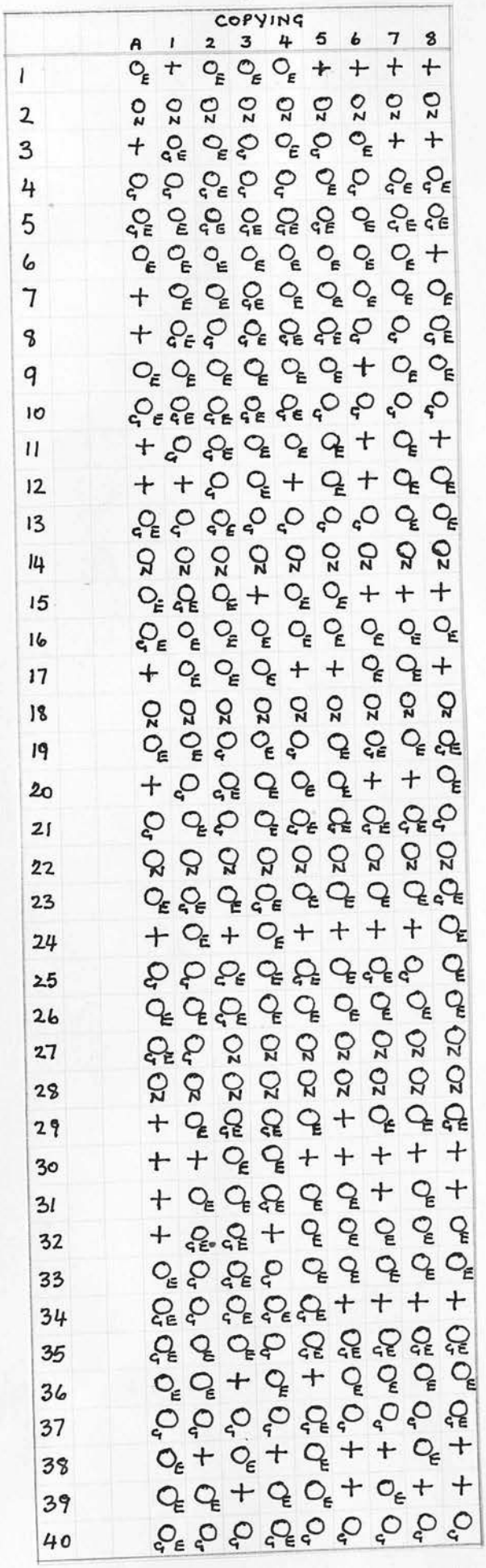

COPYING
A 1 2 3 4 5 6 7 8
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40

TABLE II

	IMMED. MEM. A	IMMED. MEM. B	COPY A	COPY B
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				
31				
32				
33				
34				
35				
36				
37				
38				
39				
40				

TABLE III

DISTRIBUTION OF CORRECT SCORES.

No. of correct responses	No. of pts.
9	–
8	–
7	1
6	1
5	2
4	5
3	4
2	3
1	4
0	20

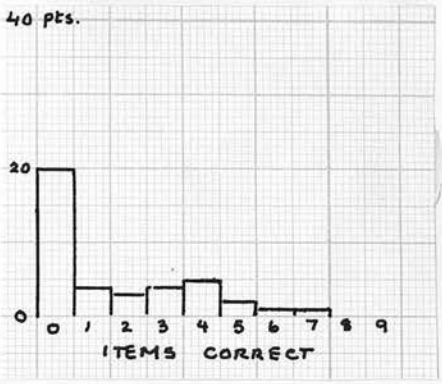


TABLE IIIi

DISTRIBUTION OF CORRECT SCORES

No. of correct responses	No. of pts	
	Copy.	Immed. memory
2	5	0
1	13	4
0	22	36

TABLE IV

ERRORS

Error	Design								
	A	1	2	3	4	5	6	7	8
correct	12	4	3	3	5	8	11	8	11
C	5	10	6	6	4	5	6	5	3
E	11	15	13	16	17	17	13	17	12
CE	7	6	12	9	8	4	4	4	8
N.	5	5	6	6	6	6	6	6	6
'C'	12	16	18	15	12	9	10	9	11
NON C	23	19	16	19	22	25	24	25	23

TABLE V

– see next page

TABLE VI

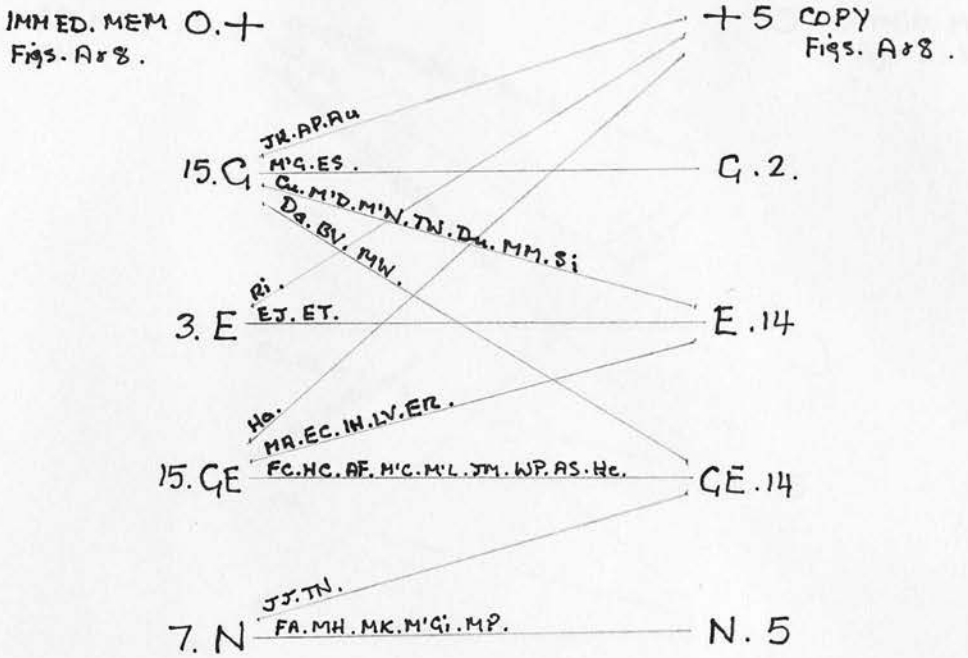
ERRORS – Figs A & 8

Error	IMMED. MEMORY			COPYING		
	A	8	TOTAL	A	8	TOTAL
C	26	26	52	12	11	23
E	14	13	27	18	20	38
N	7	7	14	5	6	11
TOTAL	47	46		35	37	

TABLE V

	(a)						(b)					
	+	G	E	GE	N		+	G	E	GE	N	
1	5		4						✓			
2					9							✓
3	3	2	3	1						✓		
4		5	1	3						✓		
5			2	7						✓		
6	1		8						✓			
7	1		7	1						✓		
8	1	3		5						✓		
9	1		8						✓			
10		4		5						✓		
11	3	1	4	1						✓		
12	4	1	4						✓			
13		5	2	2				✓				
14					9							✓
15	4		4	1						✓		
16			8	1						✓		
17	4		5						✓			
18					9							✓
19		2	5	2						✓		
20	3	1	4	1						✓		
21		3	2	4						✓		
22					9							✓
23			6	3					✓			
24	6		3					✓				
25		3	3	3				✓				
26			8	1					✓			
27		1		1	7					✓		
28					9							✓
29	2		4	3						✓		
30	7		2				✓					
31	3		5	1						✓		
32	2		5	2						✓		
33		2	6	1				✓				
34	4	2	1	2						✓		
35		1	2	6						✓		
36	2		7						✓			
37		7		2				✓				
38	5		4						✓			
39	4		5						✓			
40		8		1				✓				

DIAGRAM A



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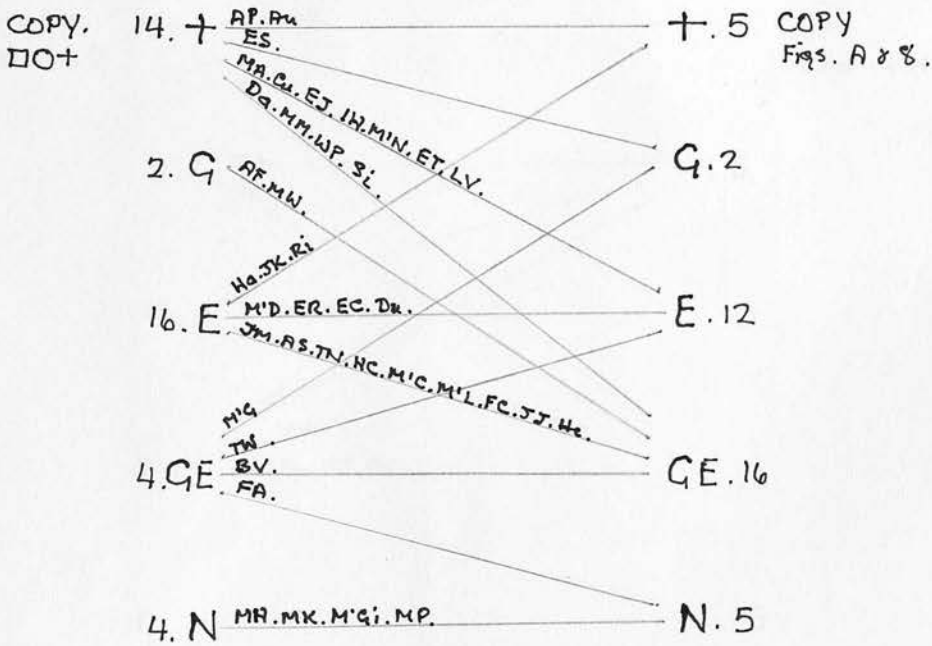

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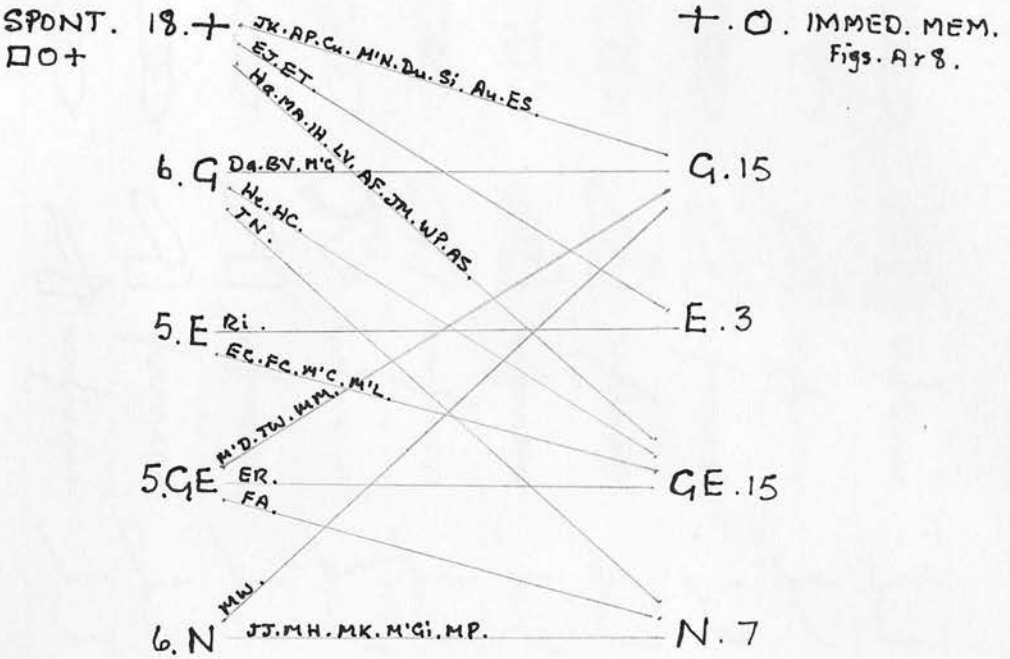

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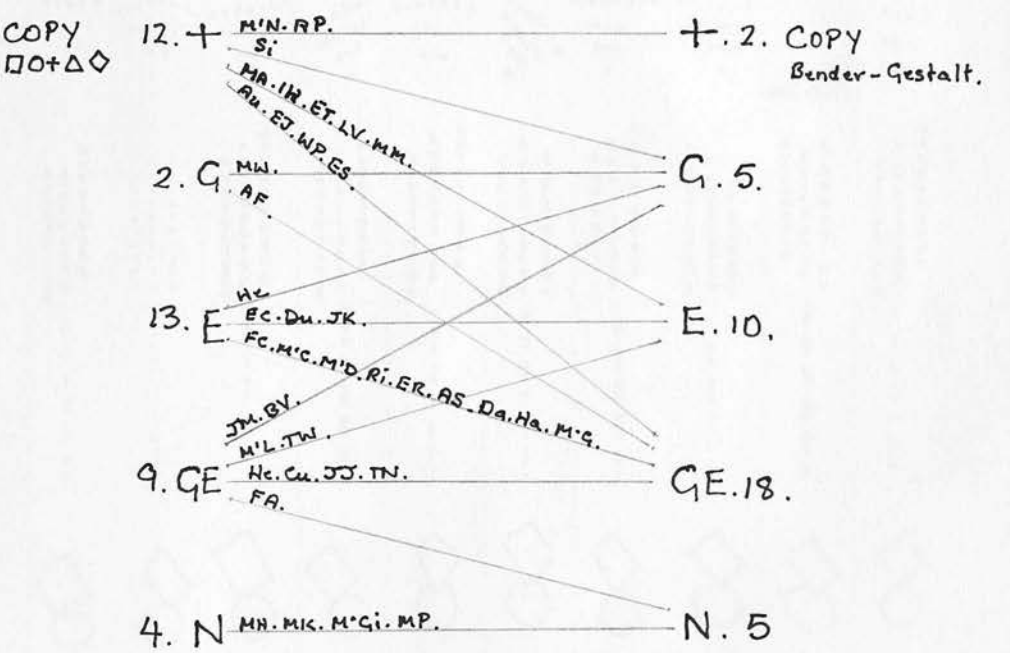


FIGURE Ic

BENDER-GESTALT — COPYING

FIGURE Ic

BENDER-GESTALT-COPYING

FIGURE I^c

BENDER-GESTALT

REPRODUCTION FROM IMMEDIATE MEMORY

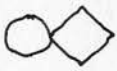
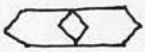
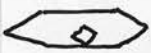
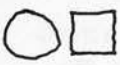
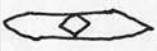
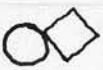
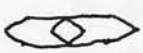
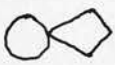
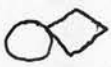
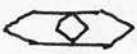
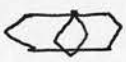
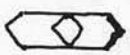
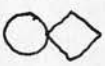
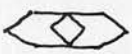
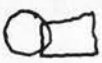
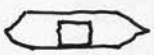
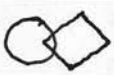
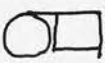
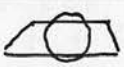
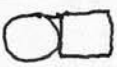
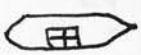
NAME	A	8	NAME	A	8
JB 1			PM'K 11		
AB 2			SMr 12		
BC 3			AM'M 13		
JC 4			JM 14		
JD 5			JP 15		
JE 6			RP 16		
SF 7			RPo 17		
AG 8			AR 18		
RH 9			SR 19		
SM'C 10			WW 20		

TABLE I^c

	COPYING								
	A	1	2	3	4	5	6	7	8
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									

TABLE II^c

	IMMED. MEM.		COPY	
	A	8	A	8
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

TABLE III^{c}

DISTRIBUTION OF CORRECT SCORES

No. of correct responses	No. of controls
9	–
8	1
7	4
6	1
5	3
4	3
3	4
2	2
1	1
0	1

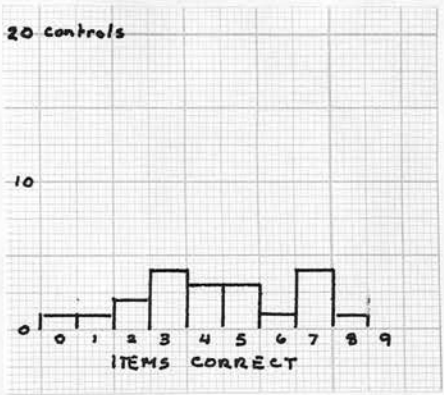


TABLE III^{ic}

DISTRIBUTION OF CORRECT SCORES

No. of correct responses	No. of controls	
	copy	immed. memory
2	6	4
1	7	7
0	7	9

TABLE IV^{c}

ERRORS

ERROR	Design								
	A	1	2	3	4	5	6	7	8
Correct	7	14	5	8	9	16	10	5	12
C	–	–	–	–	–	–	–	–	2
E	13	6	15	11	11	4	10	13	6
CE	–	–	–	1	–	–	–	2	–
N	–	–	–	–	–	–	–	–	–
'C'	–	–	–	1	–	–	–	2	2
NON C.	20	20	20	19	20	20	20	18	18

TABLE V^{c} – see next page

TABLE VI^{c}

ERRORS – Figs. A & 8

ERROR	IMMED. MEMORY			COPYING		
	A	8	TOTAL	A	8	TOTAL
C	4	5	9	–	2	2
E	11	10	21	13	6	19
N	–	–	–	–	–	–
TOTAL	15	15		13	8	

TABLE $\underline{\overline{V}}^{c}$

	(a) +	S	E	SE	N		(b) +	S	E	SE	N
1	4		5						✓		
2	7		2				✓				
3	4		5						✓		
4	3		5	1					✓		
5	7		2				✓				
6	4		4	1					✓		
7	3		6						✓		
8	3		6						✓		
9		1	7	1					✓		
10	8		1				✓				
11	6		3				✓				
12	5		4						✓		
13	5		4						✓		
14	2		7						✓		
15	7		2				✓				
16	1		8						✓		
17	3		6						✓		
18	5		4						✓		
19	2	1	6						✓		
20	7		2				✓				

DIAGRAM A^c

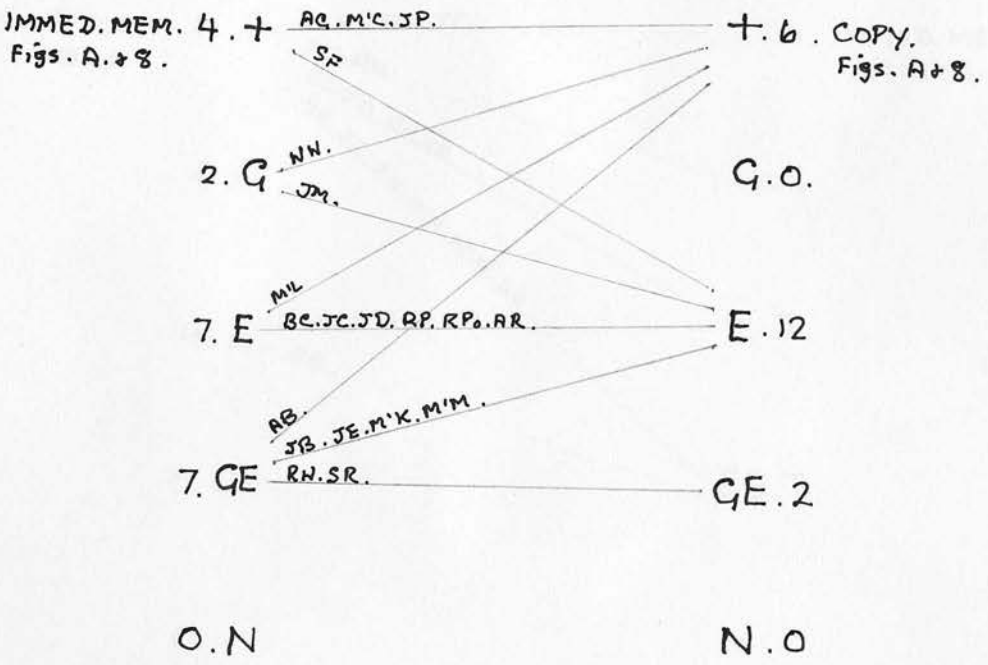


DIAGRAM B^c

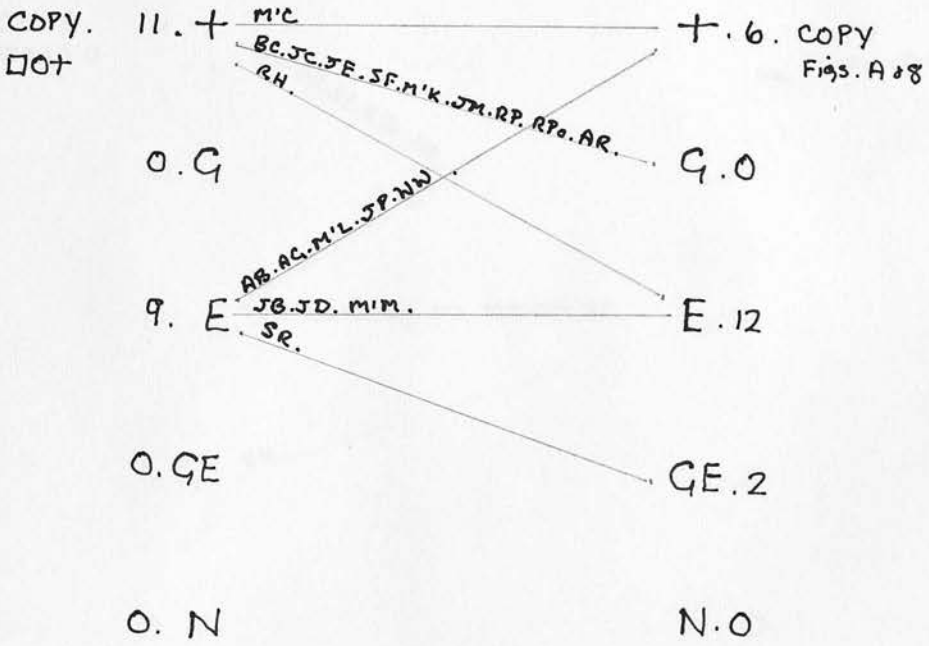


DIAGRAM C^c

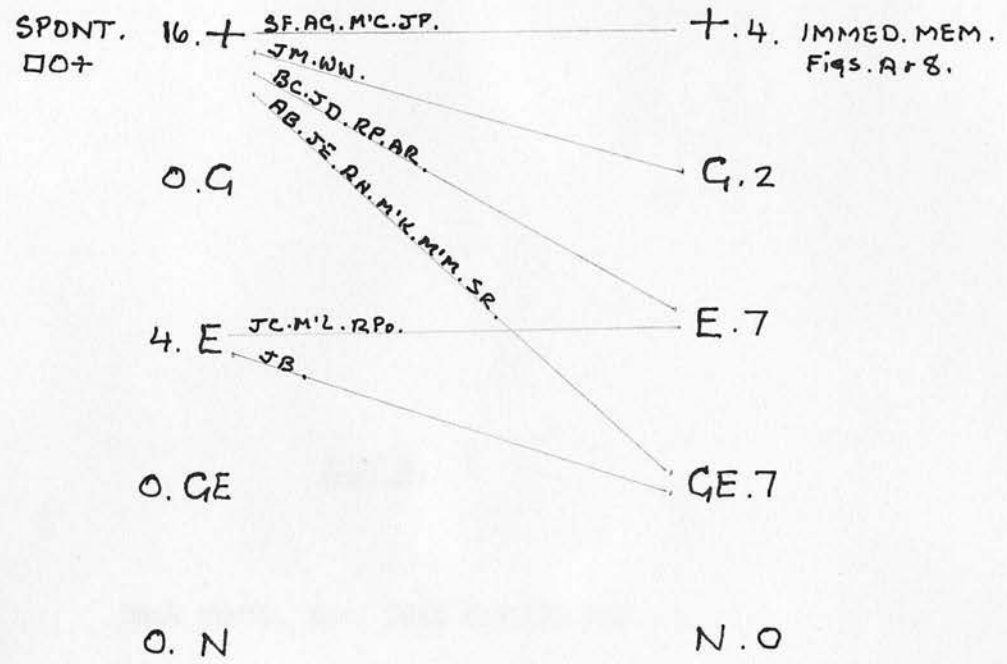
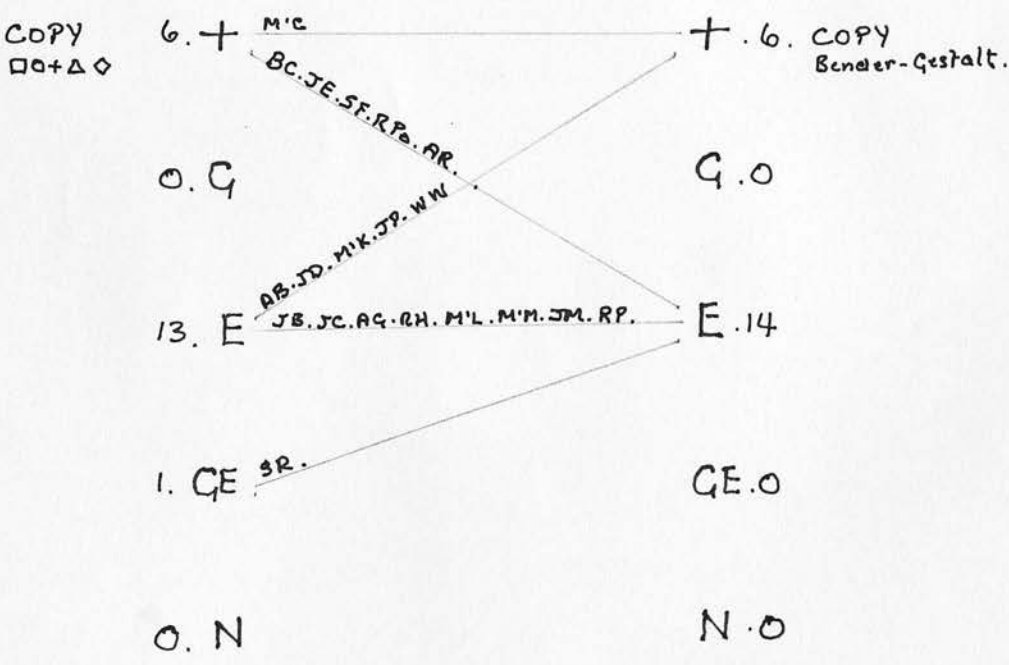


DIAGRAM D^c



TEST 8.

DRAW HOUSE, MAN, TREE AND BICYCLE.

8. SPONTANEOUS DRAWING OF HOUSE, MAN, TREE AND BICYCLE.

Figure 1 and 1c show the responses made to this test by patients and controls.

PATIENTS. The items in this test are complex and contain so many variables for consideration by comparison with those designs considered so far, that judgment of correctness of an individual patient's response here must be more subjective and therefore more arguable. Scoring is made more difficult by other factors. It is well known that in a normal population there is wide variation in artistic ability and in familiarity with drawing technique which must vary with training and interest.

Table 1 gives detail of patient responses in terms of "+" and "0". A drawing is termed "+" in this table where it fits the following three general criteria.

1. Its total form and outline should correspond to the type of object named in the instructions. This form should not be schematic or a caricature.

2. The component parts should be in good proportion to one another, to the whole form, and should be placed appropriately to the function of the object named.

3. Lines and angles should be clearly defined.

If the drawing does not meet all these conditions it is regarded as incorrect "0".

Table 11 shows the frequency of correct scores. No patient satisfies the three conditions just defined in all four drawings. Three quarters of the patients fail to draw any object to these standards. The raw scores are therefore very poor.

PATIENT ERRORS. Errors in this test can be judged in a variety of ways.

A. They can be classified in accordance with the convention already used for other tests in the series of tests under review. That is they can be defined as "G", "E" or "N" (as in Table 1) now defined.

1. "G" refers to errors of gestalt, where the patient's drawing fails to portray the object named in an identifiable form.

2. "E" refers to errors of execution where there is manifest defect in drawing lines and angles, and/or in placing component parts of the whole object correctly, or in constructing these component parts in such a way that their size is appropriate to other parts and to the whole object. Lines may be fragmented, distorted, overscored or may not meet at angles. Angles may be distorted. Component parts may be missing, dislocated or rotated.

3. "N" refers to responses where the patient refuses to draw or says he cannot begin or merely makes no effort. Table 111 shows the distribution of errors defined in this way. Out of 160 possible responses 109 fail to show a satisfactory gestalt. The table shows that "G" and "E" errors are both prominent. This table also shows up certain differences between items. The drawing of a tree has been judged correct by the standards described above, more often than any of the other drawings. This difference will be referred to again.

Executive errors alone will now be examined more closely, as by definition, they constitute a large group of errors. The drawing of a house only has been used for this closer examination, and only the 16 patients who have not shown errors of gestalt have been taken into consideration.

Executive errors have been subdivided for this purpose into two

groups whose division was indicated in the definition of "E" above.

(a) Defect of lines and angles.

Overscoring.

Fragmentation of lines.

Distortion of lines.

Lines failing to meet at angles.

Distortion of angles.

(b) Defect in the placing or proportion of component parts (spatial error).

Displaced door or window.

Omission of sides.

Failed perspective.

Chimney at right-angles to sloping roof.

Absence of detail.

Roof upside down.

Chimney overhanging side wall and roof.

Table 1V shows how patients are distributed in respect of these two kinds of error. The great majority making executive errors show both defects of lines and angles and "spatial defects" in the same response. Table V shows the number of each kind of error listed under (a) and (b) by patients. Defects of lines and angles are more common than those defects called "spatial".

B. The second method of analysis deals with the drawings in terms of the quantity of identifiable detail which they reveal irrespective of the quality of the total form. A numerical score can be given to each patient for each drawing. Thus the drawing of a house can be scored according to the number of items of detail drawn.

The following 10 items are the possible maximum. Roof, chimney, smoke, slates, door, doorhandle, steps, windows, window-frames, perspective

The following possible items in drawing a man are - nose, eyes, mouth ears, neck, hair, eyebrows, arms, fingers, feet, heels, clothes (hat, buttons, trousers).

6 items are possible in drawing a tree. Trunk, ground, roots, main branches, secondary branches, leaves.

18 items are possible in drawing a bicycle. Wheels (x 2), spokes (x 2), bars (x 6), handlbars, saddle, saddlebag, handlegrips, driving wheel, pedals (x 2), chain.

Table V1 shows detail of scores devised in this way. In the right-hand column are numbers representing a total of all the details in the four objects drawn by each patient. The mean score for each object is expressed as a percentage at the foot of each column. Below that are percentages which represent mean scores of actual drawings (i.e. leaving "0" scores out of consideration).

Mean scores are between 12 and 23% of the possible maximum.

C. It is thought of some interest to judge the drawing of a man in this test in terms of the criteria laid down by Goodenough (25) for use in the same kind of test in children. In Goodenough's test the child is asked to draw a man, and his drawing is scored on the basis of certain criteria which include not only number and quality of details present, but also standards of proportion, relationship of parts, dimension and motor co-ordination. A maximum score of 51 is possible, and any score can be compared with norms, thus giving a "drawing age".

Table V11 shows raw scores and drawing ages judged according to Goodenough's criteria. At the foot of the "drawing age" column the mean drawing age for the whole group appears; viz. 2.9 years for patients.

When only those patients who have attempted drawing are considered their mean drawing age is 5.6 years.

Table V111 shows the distribution of drawing ages among patients. One patient only achieves a drawing age above 8 andhalf the patient group achieves an age of less than 5.

D. Certain features of the drawings of these four objects remain, which are still worthy of comment.

House. 2 patients attempt and succeed in dealing with perspective (AP, ET). A number of patients who fail to draw an identifiable house nevertheless make drawings which have a box-like quality in common with that of a house and with the unidentifiable drawings of other patients (e.g. FC, Cu, Du, JJ, M'C, M'D). The other drawings of these patients (failed or not) are not basically box-like. 2 patients (Au, FC) fail to sustain their original purpose. Au's drawing which began as four slates of a large roof is completed without comment as a row of four houses each with a chimney and two with doors. FC's drawing which began as a vertical projection is completed without apology as a ground plan. 2 patients record detail only (EC, ES) neglecting the binding framework of the four walls. 5 patients (Da, M'G, M'Gi, BV, TW) write instead of drawing some part or the whole word "HOUSE" or make an effort to write the instruction "DRAW A HOUSE". The manner of this type of response is invariable. The patient puts pencil to paper repeatedly, each time appearing to be on the point of starting the drawing, but each time giving up in perplexity. In the end, in desperation, he writes the word "HOUSE" without difficulty. This occurs in spite of frequent repetition of the instructions in a variety of ways.

Man. The drawings of a man which are unidentifiable as such, differ on the whole from the unidentifiable drawing of a house. Such drawings

of a man lack the box-like quality referred to above. If they have anything in common it is merely a quality of "longitudinalness" (e.g. FC, M'L, MM, TW). There are other unidentifiable drawings however which lack even this quality. (AF, JJ, M'D, JM, WP). One patient (Si) hesitates in her purpose in mid drawing. Having completed one set of head, trunk and legs, she adds another trunk and legs distal to the first set. One patient (ES) draws disorganised parts out of framework. This patient had already drawn a house with the same type of defect. Three patients draw diagramatic men (Cu, JM, ER) which are merely suggestive of the required object, and perhaps at best indicate only a class of animate objects rather than a man in particular. JM's response considered together with her drawing of a tree and house is clearly a perseveration in which two sides of a triangle is the perseverated theme. This is the only example of perseveration. Four patients try to write the word MAN (FE, Hc, JK, BV). Seven patients who draw in profile all direct the face towards the left-hand side of the page.

Tree. Those drawings which are unidentifiable as trees do nevertheless have something in common which may be an impression of a stal with something spreading out above or merely the stalk alone (Au, FC, Du, JJ, JK, M'C). Three patients perseverate clearly (AF, JM, Si). Their drawings however show signs of "treeness" with evidence of features of the previously drawn object at the same time. Af. begins to draw a tree to which she adds a roof. JM. draws the inverted V which appears in her two previous drawings and adds twigs to it. Si. draws the trunk of a tree which she completes as a chimney stack which had appeared on her house. One patient (He.) tries to write the word TREE.

Bicycle. The unidentifiable drawings have features in common distinguishing them from the unidentifiable drawings of other objects,

e.g. wheels and spokes sometimes occur together with connecting lines (MA, FA, Au, EC, Ha, IH, MM, TW). One patient tries to write the word BICYCLE (FC). One patient certainly perseverates on the theme of a house (Si). In the three drawings which are unmistakably directed (M'N, WP, AP), the front faces left in all. In fourteen cases where two wheels are drawn, ten patients draw the left wheel obviously larger than the right. In the other four the size of the two wheels is equal.

SUMMARY OF PATIENT RESPONSES.

1. Evaluation of results is difficult because of the complexity of the objects to be drawn and because of probable wide variation in past drawing experience.

2. Correct responses are rare, but standards of scoring are strict.

3. Errors of gestalt and errors of execution are identifiable and common in patient responses.

4. Errors of execution have been subdivided into "spatial" errors and defects of lines and angles. These tend to occur together in patient responses, though in total, errors of lines and angles outnumber spatial errors.

5. 7 patients only achieve a volume of detail which would raise their drawings above rudimentary.

6. Using norms defined for children's drawings of a man, the patient group as a whole achieves a drawing age of 2.9 years. When only those who draw are considered, the drawing age is 5.6 years.

7. Unidentifiable drawings of any one object tend to have features in common, and to be different from the unidentifiable drawings of any other object.

8. Perseveration is rare.

9. To some extent the evaluation of results to fixed criteria

depends on the nature of the object.

10. There is a marked tendency to direct the drawings of certain assymetrical objects (profile man and bicycle) towards one side of the p

CONTROLS. Table 1c gives detail of control responses in terms of "+" and "0". The same criteria as were used for patients is used again Table 11c shows the frequency of correct scores. No control subject satisfies all the conditions of correctness in all four drawings. Nearl half the group fails to draw any object to the required standards. The raw scores are therefore poor.

CONTROL ERRORS. These will be considered in the same way as were errors in patients.

A. In terms of errors of gestalt and execution, Table 111c shows the distribution of errors defined in this way. In the control group executive errors outstandingly account for failure while other errors (of gestalt and refusals) are trivial (only 6 out of 80 possible responses) or absent. Portrayal of gestalt is good and defect is confined to execution. Table 111c shows that the tree is judged corre more often than the other objects.

Table 1Vc shows how controls are distributed in respect of the two kinds of executive error defined; viz. "spatial" errors and errors of lines and angles. In this group the two types of error are to a large extent mutually exclusive. Table Vc shows that in controls "spatial" errors outnumber errors of lines and angles.

B. Volume of identifiable detail.

Table V1c shows detail of scores. Mean scores are around 50% (42 - 53%) of the possible maximum.

C. Drawing of a man (judged in terms of Goodenough's norms).

Table V11c shows raw scores and drawing ages. At the foot of the "drawing age" column, the mean "drawing age" of control group appears; viz. 6.6 years.

Table V111c shows the distribution of drawing ages among controls. This tends to be "normal". No subject has a drawing age above 10 or below 3 years.

D. Other features.

House. Efforts to portray perspective are rare. Only 2 cases try (JE, WW), and 1 fails. The "houses" of control cases are otherwise formal, two-dimensional impressions which are mainly symmetrical. The most obvious abnormalities are omission of side walls (AG, SM'G, SR), displacement of doors away from ground level without steps (AB, JM, RPo, SR), and construction of chimneys at right-angles to a sloping roof (JB,

Man. These are largely childish. Half are of the kind where two circles are drawn for head and trunk. 2 cases (JB, AR) draw heads which show features of full profile and full face at the same time. 3 cases (JB, AB, JC) omit arms altogether. The 7 cases who draw in profile all direct the face towards the left side of the page.

Tree. This is best performed in terms of correct scores (v.s.). Many correct drawings are nevertheless primitive and have been judged correctly only because these are drawings of objects which are in reality primitive. The nature of the object itself leaves room for vagueness and imprecision in drawing, within the limits of "rightness", which the other objects would not. Both drawings which were taken to be not immediately identifiable as trees (JB, AR) have in common with most of the other drawings of trees detail, which could be sprouting twigs or branches.

Bicycle. Many cases draw objects which are hardly bicycles as we

know them today but are clearly two-wheeled machines. Many of these lack anything like a driving mechanism (pedals or chain). The system of bars which goes to make up the frame has been achieved with accuracy by only 1 (SM'G). The majority have the general appearance of a bicycl nevertheless. 4 drawings which fail in this respect have unmistakable signs, viz. wheels. Of the 16 identifiable bicycles 14 face towards the left of the page, 1 faces the other way (SM'C) and the direction of the other is indeterminate (SR). Of these 16 the left wheel is clearly larger than the right in 14 drawings. In only 1 is the reverse true (WW) and in only 1 do they appear equal in size (SM'C).

SUMMARY OF CONTROL RESPONSES.

1. Correct responses are rare.

2. Errors of gestalt are rare. Errors of execution almost wholl account for failure.

3. Errors of execution have been subdivided into "spatial" errors and defects of lines and angles. These tend to be mutually exclusive in control responses.

4. The control group as a whole achieves a high volume of detail in drawing.

5. Using Goodenough's norms for the drawing of a man the control group as a whole achieves a drawing age of 6.6 years.

6. Unidentifiable drawings are rare. None occurs in house, man or tree.

7. Perseveration does not occur.

8. Evaluation of results to fixed criteria depends on the nature of the object.

9. There is a marked tendency to direct the drawings of certain

assymetrical objects towards one side of the page.

PATIENT-CONTROL CONTRAST.

1. No individual in either group draws all four objects correctly The raw scores in both groups are poor, and rather worse in patients than controls.

2. Though the frequency of errors is not greatly different betwee the two groups, the character of the errors is widely different. The frequency of executive errors is similar in both patients and controls, whereas errors of gestalt, which are common in patients are rare among controls.

3. When the two types of executive error are considered ("spatial and defects of lines and angles) they are found to occur together in patients but are mutually exclusive among controls. "Spatial" errors occur with much the same frequency irrespective of group, whereas defect of lines and angles occur much more commonly in patients than in controls. Patients who achieve gestalt in drawing therefore differ from normal controls in respect of these lines and angles.

4. Only 7 patients out of 40 achieve scores of detail which are within the range of normal control performance. The remaining 33 patie fail to achieve total scores which are as good as the lowest control total score.

5. The mean "drawing age" of the two groups is very different. If only those who draw are considered among patients then the difference is slight. The distributions of the two groups are different. The control group shows a normal distribution.

6. Certain drawings in both patient and control groups show a tendency to be directed towards one side of the page. Profile man

and bicycle on the whole point to the left.

FIGURE I

DRAW HOUSE, MAN, TREE, BICYCLE

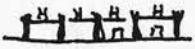
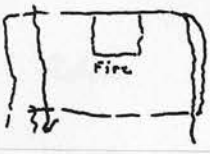
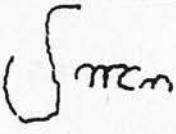
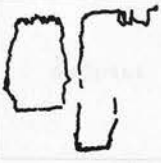
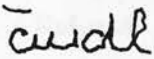
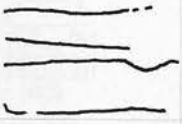
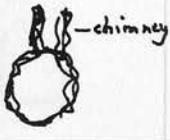
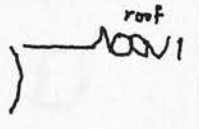
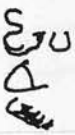
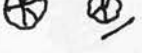
NAME	HOUSE	MAN	TREE	BICYCLE
MR 1				
FA 2				
Au 3				
FC 4				
HC 5		No response	No response	No response
EC 6				
Cu 7				No response
Da 8	writes instructions	Refuses	Refuses	Refuses
Da 9				Don't Know
AF 10				

FIGURE I

DRAW HOUSE, etc.

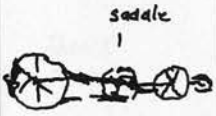
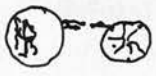
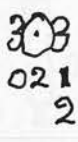
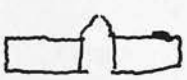
NAME	HOUSE	MAN	TREE	BICYCLE
Ha 11				
IH 12				
He 13		writes 'MAN'		Don't Know
MH 14	Refuses	Refuses	Refuses	Refuses
EJ 15				
JJ 16				Don't Know
JK 17				
MK 18	Refuses	Refuses	Refuses	Refuses
M'C 19				
M'D 20				

FIGURE I

DRAW HOUSE, etc.

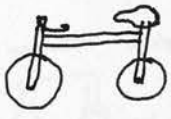
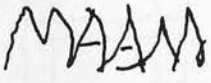
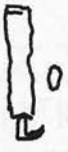
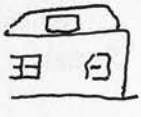
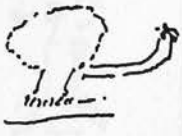
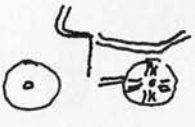
NAME	HOUSE	MAN	TREE	BICYCLE
M'G 21	Writes "HOUSE"	Don't Know	Don't Know	Don't Know
M'Gi 22	H	Writes own name	Refuses	Refuses
M'L 23				
M'N 24				
JM 25				
MM 26				
TN 27	Refuses	Refuses	Refuses	Refuses
MP 28	Refuses	Refuses	Refuses	Refuses
WP 29				
AP 30				

FIGURE I

DRAW HOUSE, etc.

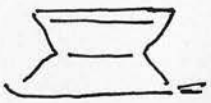
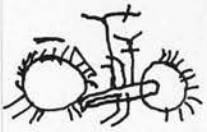
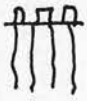
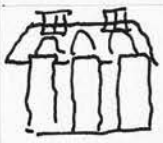
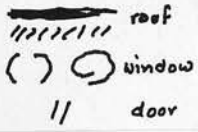
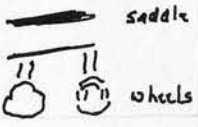
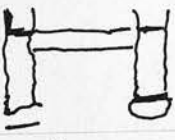
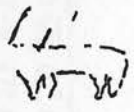
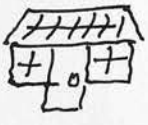
NAME	HOUSE	MAN	TREE	BICYCLE
Ri 31				
ER 32			Tr 	
Si 33				
ES 34	 roof window door	 neck chest		 saddle wheels
AS 35		Refuses		Refuses
ET 36				
BV 37	writes 'DRAW HOUSE'	Tries to write 'DRAW A MAN'	Refuses	Refuses
LV 38				
TW 39	writes 'HOUSE'			
MW 40	Refuses	Refuses	Refuses	Refuses

TABLE I

	HOUSE	MAN	TREE	CYCLE
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				
31				
32				
33				
34				
35				
36				
37				
38				
39				
40				

TABLE II
DISTRIBUTION OF CORRECT SCORES

No. of correct responses	No. of Pts.
4	0
3	1
2	1
1	7
0	31

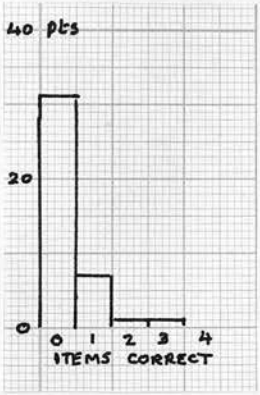


TABLE III
ERRORS

ERROR	Design				
	House	Man	Tree	Cycle	Total
+	2	1	8	1	12
G	6	8	7	9	30
E	14	13	8	4	39
GE	13	10	8	12	43
N	5	8	9	14	36

TABLE IV
ERRORS

ERROR	No. of Pts.
1. Spatial alone	1
2. Lines & Angles alone	2
3. 1+2	11
Correct	2

TABLE V
ERRORS

ERROR	No. of Pts.
Spatial	13
Lines & Angles	26

TABLE VI – see next page

TABLE VII – see next page

TABLE VIII
ERRORS

Drawing Age	No. of Pts.
11-12 years	1
9-10 "	0
7-8 "	5
5-6 "	6
3-4 "	9
< 3 "	19

TABLE VI

	HOUSE	MAN	TREE	CYCLE	TOTAL
1	2	3	1	4	10
2	4	4	2	3	13
3	2	3	2	2	9
4	0	0	1	0	1
5	0	0	0	0	0
6	1	1	1	3	6
7	1	4	1	0	6
8	0	0	0	0	0
9	1	5	2	0	8
10	1	0	0	3	4
11	7	7	2	6	22
12	3	4	2	4	13
13	1	0	0	0	1
14	0	0	0	0	0
15	7	7	4	5	23
16	0	1	0	0	1
17	1	0	1	0	2
18	0	0	0	0	0
19	0	2	1	0	3
20	0	0	1	1	2
21	0	0	0	0	0
22	0	0	0	0	0
23	2	0	2	4	8
24	5	6	3	8	22
25	0	1	1	1	3
26	3	1	3	3	10
27	0	0	0	0	0
28	0	0	0	0	0
29	3	1	5	6	15
30	8	9	5	11	33
31	4	7	4	6	21
32	0	1	4	6	11
33	4	6	0	0	10
34	3	4	3	6	16
35	1	0	0	0	1
36	6	0	0	4	10
37	0	0	0	0	0
38	6	7	3	6	22
39	0	0	3	1	4
40	0	0	0	0	0
	19·0	17·5	23·7	12·9	= % mean score of 40 pts.
	31·7	33·3	39·6	24·6	= % mean score of those who draw.

TABLE VII

	RAW SCORE	DRAWING AGE
1	12	5·5 yrs
2	10	5
3	8	4·5
4	0	0
5	0	0
6	9	5
7	6	4
8	0	0
9	12	5·5
10	1	3
11	20	7·5
12	15	6
13	0	0
14	0	0
15	24	8·5
16	2	3
17	0	0
18	0	0
19	8	4·5
20	0	0
21	0	0
22	0	0
23	3	3
24	20	7·5
25	5	4
26	0	0
27	0	0
28	0	0
29	0	0
30	37	12
31	17	7
32	6	4
33	15	6
34	6	4
35	0	0
36	0	0
37	0	0
38	20	7·5
39	0	0
40	0	0
	2·92	= mean age
	5·57	= mean age of those who draw

FIGURE I[c]

DRAW HOUSE, MAN, TREE, BICYCLE

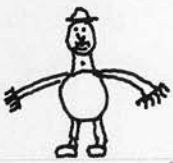
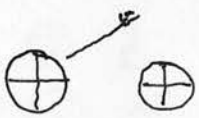
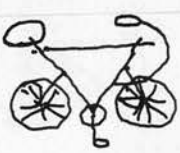
NAME	HOOSE	MAN	TREE	BICYCLE
JB 1				
AB 2				
BC 3				
JC 4				
JD 5				
JE 6				
SF 7				
AG 8				
RH 9				
SM'C 10				

FIGURE 1c

DRAW HOUSE, etc.

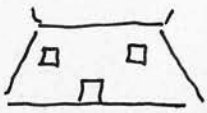
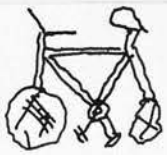
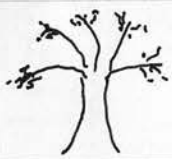
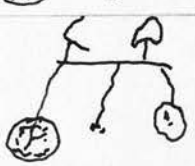
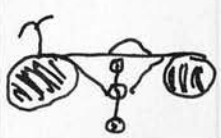
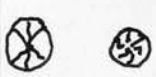
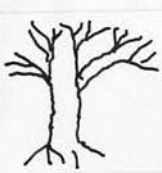
NAME	HOUSE	MAN	TREE	BICYCLE
PMK 11				
SM'L 12				
AM'M 13				
JM 14				
JP 15				
RP 16				
RPo 17				
AR 18				
SR 19				
WW 20				

TABLE I[C]

	HOUSE	MAN	TREE	CYCLE
1				
2			+	
3	+		+	
4				
5			+	
6				
7			+	
8			+	
9			+	
10				
11	+		+	
12				
13	+		+	
14			+	
15			+	
16				
17				
18				
19				
20		+	+	

TABLE II[C]

DISTRIBUTION OF CORRECT SCORES

No. of correct responses	No. of controls
4	0
3	0
2	4
1	7
0	9

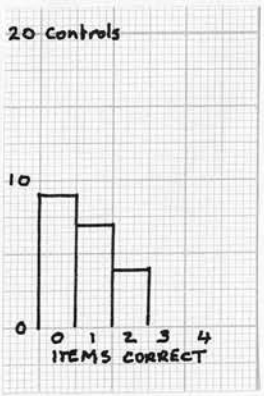


TABLE III^c
ERRORS

ERROR	Design				
	House	Man	Tree	Cycle	Total
Correct	3	1	11	–	15
G	–	–	2	2	4
E	17	19	7	16	59
GE	–	–	–	2	2
N	–	–	–	–	–

TABLE IV^c
ERRORS

ERROR	No. of controls
1. Spatial alone	8
2. Lines & Angles alone	5
3. 1 + 2	4
Correct.	3

TABLE V^c
ERRORS

ERROR	No. of controls
Spatial	17
Lines & Angles	9

TABLE VI^{c}

	HOUSE	MAN	TREE	CYCLE	TOTAL
1	2	5	2	7	16
2	3	4	1	10	18
3	5	7	2	2	16
4	4	2	2	8	16
5	3	5	3	10	21
6	6	5	1	5	17
7	8	5	5	8	26
8	6	3	3	5	17
9	6	2	3	8	19
10	5	4	3	14	26
11	7	5	3	10	25
12	3	4	2	14	23
13	5	7	5	14	31
14	4	3	1	9	17
15	7	8	3	10	28
16	9	8	3	5	25
17	5	7	3	6	21
18	6	7	2	12	27
19	5	3	4	10	22
20	8	9	4	14	35

53·5 42·9 45·8 50·2 = % mean scores

TABLE VII^{c}

	RAW SCORE	DRAWING AGE
1	13	6 yrs.
2	11	5
3	20	7·5
4	12	5·5
5	17	7
6	17	7
7	16	6·5
8	7	4
9	15	6
10	13	6
11	19	7
12	18	7
13	23	8
14	13	6
15	20	7·5
16	28	9·5
17	16	6·5
18	11	5
19	9	5
20	31	10

6·6 yrs = mean drawing age.

TABLE VIII^{c}
ERRORS

Drawing age	No. of controls
11-12 years	0
9-10 "	2
7-8 "	7
5-6 "	10
3-4 "	1
< 3 "	0

TEST 9.

M A N N I K I N.

9. ASSEMBLY OF WECHSLER-BELLEVUE MANNIKIN.

Figures 1 and 1c show the responses to this test by both patients and controls. Correct responses are represented by "+". Incorrect responses in assembly are shown in a diagramatic way. In the figure, [] represents the trunk; ⊙ the head; ↓ and ↓ the upper and lower limbs respectively. There are a large variety of different possible responses. For example, when the mannikin is constructed with the left arm placed so that hand is apposed to shoulder but where there is no other error then the result is represented thus.

Where the right and left arms are reversed as the only error then:-

Where the left arm and leg are neglected as the only error:-

Where the left arm is placed where the right leg should be, and the right leg is placed in the position of the left arm, then:-

There are many other possibilities which it is now hoped will be self-explanatory.

"0" indicates that no response occurs or that the subject refuses to respond.

PATIENTS. Table 1 shows detail of individual responses in identifying the scattered pieces and in assembling these pieces. In Column (a) "+" means that the patient has identified the unassembled

pieces for what they are; namely a human figure. "0" means that he has failed to do this. In Column (b) "+" means that the subject has assembled the pieces quite correctly. "0" means that there has been some degree of failure in assembly. Table 11 shows the distribution of correct scores in each part of the test. Half the patients identify the scattered pieces correctly. 7 patients only assemble correctly.

PATIENT ERRORS. The symbols "G" "E" and "N" have been used again to represent different types of faulty response in assembly. By the nature of the material used and the character of the manipulation required these symbols need further definition as they apply to errors in this test.

1. "G" refers to an error where the required human form has not been conveyed by the patient's assembly of the parts, but where nevertheless some structure has been attempted.

2. "E" refers to an error where it is clear from the patient's response that he has a notion of the human form required and conveys it in his construction but makes one or more of the following errors:-

Reverses limbs (with regard to laterality).

Places limbs "hand to shoulder" or "foot to hip". or

Makes long trial and error before correct assembly is achieved.

3. "GE" refers to an error where after tentatively fingering the pieces for some time the patient places them in linear series on the table, thereby achieving a structure which bears no resemblance to the required form. This differs from the confident manipulation of pieces into the wrong form which has been defined as "G".

4. "N" refers to refusal, no effort, etc.

Table 111 shows the frequency with which each type of error occurs. They are seen to be fairly evenly distributed between the various types. The distribution of errors among those who identify the scattered pieces

correctly compared with those who fail to identify, is shown in Diagram A and the table below it. The diagram shows that all 7 patients who assemble correctly are derived entirely from those who identify correctly. Those who make "E" errors mainly derive from the group which identifies correctly, but 4 of those who make only "E" errors belong to the group who fail to identify the scattered parts. The great majority (17) of the remaining errors in assembly (i.e. "G" "GE" and "N") occur in patients who fail to identify the scattered parts. There is a small group (MM, Au, EC, Hc, Si) which, while succeeding in the identification of the parts, fails in assembly.

SUMMARY OF PATIENT RESPONSES.

1. Less than one quarter of the patients perform both parts of the test correctly. The 7 patients who assemble correctly all perceive the nature of the scattered parts.

2. All the patients who assemble correctly and most of those who make only minor errors of limb placing ("E" errors) are derived from the group which identifies the scattered pieces correctly. The majority of patients who fail grossly in assembly ("G" "GE" and "N" errors) derive from the group which fails to identify the scattered parts correctly.

CONTROLS. Table 1c shows detail of individual control responses in identifying the scattered pieces and in assembling them. Identification (Column (a)) is performed correctly by all 20 subjects. 16 subjects assemble the pieces correctly.

CONTROL ERRORS. Table 111c shows the frequency occurrence of each type of error. 4 subjects only make errors in assembly and these are all by definition "E" errors.

SUMMARY OF CONTROL RESPONSES.

1. More than three quarters of the control group perform both parts of the test correctly. All control subjects identify the scattered pieces correctly.

2. All errors are executive. No error of gestalt is made by any member of this group.

PATIENT-CONTROL CONTRAST.

1. There is a very striking difference between the two groups in the frequency of wholly correct responses.

2. Identification of scattered pieces is perfect in the control group but only half the patient group identifies correctly.

3. 7 out of 40 patients assemble correctly. 16 out of 20 controls assemble correctly.

4. The great majority of errors in the patient group are of a kind in which the gestalt is not conveyed in the response. This is not true of any member of the control group where no gestalt error occurs.

FIGURE 1

MANNIKIN — ASSEMBLY

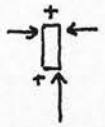
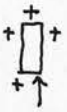
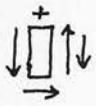
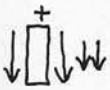
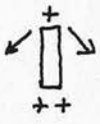
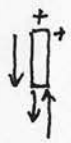
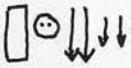
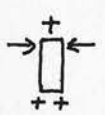
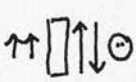
NAME	RESPONSE	NAME	RESPONSE	NAME	RESPONSE	NAME	RESPONSE
MA 1		Ha 11		M'G 21		Ri 31	
FA 2		IH 12		M'Gi 22		ER 32	
Au 3		We 13		M'L 23		Si 33	
FC 4		MH 14		M'N 24		ES 34	
HC 5		EJ 15		JM 25		AS 35	
EC 6		JJ 16		MM 26		ET 36	
Cu 7		JK 17		TN 27		BV 37	
Da 8		MK 18		MP 28		LV 38	
Du 9		M'C 19		WP 29		TW 39	
AF 10		M'D 20		AP 30		MW 40	

TABLE I

	a) IDENTIFICATION.	b) ASSEMBLY
1	+	○E
2	+	○E
3	+	♀○E
4	○	♀○E
5	○	○N
6	+	♀○E
7	+	+
8	○	○N
9	+	○E
10	○	♀○
11	+	+
12	+	+
13	+	○N
14	○	○E
15	+	+
16	○	♀○
17	○	♀○
18	○	○N
19	○	♀○
20	○	♀○
21	○	♀○E
22	○	○N
23	○	♀○
24	+	○E
25	+	+
26	+	♀○
27	○	♀○E
28	○	♀○E
29	○	○E
30	+	+
31	○	○E
32	○	○E
33	+	○N
34	+	○E
35	+	○E
36	+	+
37	○	○N
38	+	○E
39	○	♀○E
40	○	♀○E

TABLE II

DISTRIBUTION OF CORRECT SCORES

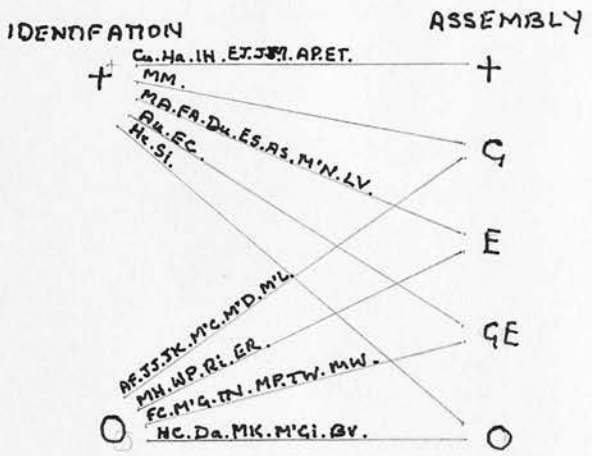
Response	No. of patients	
	Identification	Assembly
Correct	19	7
Failed	21	33

TABLE III

ERRORS IN ASSEMBLY

Error	No. of pts.
correct	7
G	7
E	11
GE	9
N	7

DIAGRAM A



Error	IDENTIFICATION	
	+	O
Correct	7	0
G	1	6
E	7	4
GE	2	6
N	2	5

FIGURE Ic

MANNIKIN — ASSEMBLY

NAME	RESPONSE	NAME	RESPONSE	NAME	RESPONSE	NAME	RESPONSE
JB 1	+	JE 6	+	PM'K 11	+	RP 16	+
AB 2		SF 7	+	SM'L 12	+	RPo 17	+
BC 3	+	AG 8	+	AM'M 13	+	AR 18	+
JC 4	+	RH 9		JM 14		SR 19	+
JD 5	+	SM'C 10	+	JP 15	+	WW 20	+

TABLE I[c]

	a) IDENTIFICATION.	b) ASSEMBLY
1	+	O_E
2	+	O_E
3	+	+
4	+	+
5	+	+
6	+	+
7	+	+
8	+	+
9	+	O_E
10	+	+
11	+	+
12	+	+
13	+	+
14	+	O_E
15	+	+
16	+	+
17	+	+
18	+	+
19	+	+
20	+	+

TABLE II[c]

DISTRIBUTION OF CORRECT SCORES

Response	No. of Controls	
	Identification	Assembly
Correct	20	17
Failed	0	3

TABLE III[c]

ERRORS IN ASSEMBLY

ERROR	No. of controls
Correct	17
G	0
E	3
GE	0
N	0

TESTS 10 AND 11.

CONSTRUCTING PLAIN BLOCK DESIGNS.

1. COPYING.
2. REPRODUCTION FROM IMMEDIATE MEMORY.

10. COPYING PLAIN BLOCK DESIGNS.

11. REPRODUCTION OF PLAIN BLOCK DESIGN FROM IMMEDIATE MEMORY.

Figures 1 and 1c show the responses to both these tests by patients and controls.

PATIENTS. Table 1 shows the distribution of correct scores. The levels of scores seem randomly distributed in the direct copying task, whereas in reproduction fromimmediate memory poor scores are common and good scores are rare.

Table 11 shows the frequency with which each design is correctly constructed under the two conditions of direct copying and reproduction from immediate memory. In both, the number of correct scores tends to diminish progressively from Design 1 to 8. Design 3 in reproduction from immediate memory does not fit this trend. The number of times it is correctly scored is almost as infrequent as in Design 8.

PATIENT ERRORS. Consideration of faulty responses in items of these two tests suggests that errors must be judged in respect of three variables.

(1) The number of blocks involved in a design.

(2) The number of dimensions involved. Design 1 is regarded as one-dimensional; Designs 2, 4, 5 and 6 as two-dimensional, and Designs 3, 7 and 8 as three-dimensional.

(3) The symmetry of the design asked for. Designs 1, 3, 4, 5 and 7 are symmetrical and the others are not.

Table 111 is devised to illustrate how each item is performed with regard to these three variables. Where the response is wholly correct the item is scored "+". Where a design is constructed which has the same number of blocks and the same number of dimensions as the model but is wrong in respect of symmetry, it is scored thus:- $\overset{+}{\circ}\!\!+$. Where the

number of blocks only is wrong then the response is scored  .
Where the number of dimensions only is wrong the response is scored  .
There are therefore a variety of possible responses
Where there is no response, as in refusal, the item is scored "0".

Table V considers the 8 designs in these two tests. The numbers refer to the frequency with which each design is correctly performed in respect of each variable described above separately. Table 1V gives detail of the number of blocks in each design, and the dimension and symmetry of each design. Some aspects of these results will now be pointed out.

COPYING. There is not an exact correspondence between the number of blocks involved in a design and the frequency with which it is correctly performed in respect of numbers. The two designs (1 and 2) which contain fewest blocks are most often correctly constructed. The exact correspondence is also lacking in the factor of dimension, though again the design with only one dimension (1) is most often constructed correctly in respect of dimension. There is closer correspondence between symmetry and the frequency with which designs are correctly performed in respect of symmetry. Those designs which are asymmetrical (2, 6 and 8) are least frequently constructed correctly in this respect.

REPRODUCTION FROM IMMEDIATE MEMORY. There is almost exact correspondence between results judged in terms of numbers correct and actual number of blocks in each design. The designs with least blocks are often constructed correctly in respect of numbers. Those with most blocks (3, 7 and 8) are least often correctly performed. Correspondence between correct performance in terms of dimension and the actual dimensions of a design is greater than in copying. Correspondence between correct performance in terms of symmetry and the actual symmetry

of designs is close. The symmetrical designs are more often constructed correctly in this respect than the asymmetrical ones.

Table V1 shows a simple division of responses. The first rank "+" shows the frequency of correct responses. The second rank shows responses where one or more but not allof the three factors is demonstrate in the construction. The third rank shows responses where either no construction has been attempted or, if it has, none of the three factors is demonstrated. The last type of response figures prominently under both conditions.

SUMMARY OF PATIENT RESPONSES.

1. Direct copying is more successful than reproduction from immediate memory. The character of the distribution of successful scores throughout the group is strikingly different.

2. There is a progressive fall in the frequency of correct scores between Design 1 and 8 under both conditions. Design 3 in reproduction from immediate memory does not fit this trend.

3. Construction of these designs involves three factors:-

(1) Number of blocks.

(2) Dimensions of designs.

(3) Symmetry of designs.

All three factors appear to influence success or failure in construction in reproduction from immediate memory. Only the factor of symmetry has this influence in direct copying.

4. Total failures "0" are prominent.

CONTROLS. Table 1c shows the distribution of correct scores. Copying the 8 designs is done without error by all 20 control subjects. In reproduction from immediate memory no subject fails in all 8 designs.

2 subjects only fail in the construction of more than 4 designs.

Table 11c shows that all 8 designs are copied correctly by all 20 control subjects. In reproduction from immediate memory Designs 1, 2 and 4 are constructed correctly by 19 out of 20 subjects, Designs 3, 5, 6 and 7 by 13 - 16 out of 20, and Design 8 by only 6 out of 20 subjects.

CONTROL ERRORS. These have been considered in the same way as patient errors. Table 111c shows individual errors in detail. Table 1Vc corresponds to Table V for patients.

COPYING. Shows no errors.

REPRODUCTION FROM IMMEDIATE MEMORY. No striking correspondence can be seen between the three factors and the scores considered in respect of them. Correct number of blocks and symmetry are infrequently achieved in Design 8, but its dimensions are achieved correctly by all but one of the control subjects.

Table Vc corresponds to Table V1 devised for patients. The striking feature of this table is the lack of total failure to demonstrate any of the factors involved in construction of these designs. In other words all the subjects either construct correctly or at least manage to demonstrate one or more of the factors.

SUMMARY OF CONTROL RESPONSES.

1. Copying is more accurate than reproduction from immediate memory. The former is faultless, and in the latter no subject fails in all 8 designs.

2. In reproduction from immediate memory there is a progressive fall in the frequency of correct scores between Design 1 and 8. Design 3 again occupies a scoring position which does not fit this trend.

3. None of the three factors involved in the designs appear to

have a clear influence on their construction.

4. Total failures "0" are very rare.

PATIENT-CONTROL CONTRAST.

1. Performance in both parts of the test is better by controls than patients. Direct copying is perfect in the control series. Only 8 patients out of 40 achieve perfect scores in direct copying.

2. In reproduction from immediate memory the first 4 designs in both groups are constructed better than the last 4. Design 3 in both groups is an exception to this.

3. The three factors involved in construction can be seen to influence scores in the case of patients, but not in controls.

4. Total failure to demonstrate any of the three factors is common in the patient group but very rare in controls.

FIGURE I

PLAIN BLOCK DESIGNS — COPYING

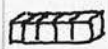
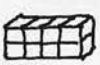
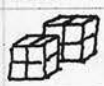
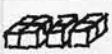
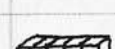
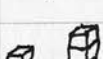
NAME	1	2	3	4	5	6	7	8
MA 1	+	+	+	+	+	+	+	+
FA 2	Refuses	Refuses	Refuses	Refuses	Refuses	Refuses	Refuses	Refuses
Au 3	+	+	+		+	+	+	
FC 4	+				Adds to model	Adds to model	Adds to model	Adds to model
HC 5			No Response	No Response	No Response	No Response	No Response	No Response
EC 6	+	+	+	+	+	+	+	+
Cu 7	+	+		+	+	+	+	
Do 8	+							No Response
Du 9	+	+		Refuses	Refuses	Refuses	Refuses	Refuses
AF 10	+	+		+				
Ha 11	+	+			+	+	+	+
IH 12	+	+	+	+	+	+	+	+
Hc 13	+	+			+			Don't Know
MH 14	+	+		+	+	+		Refuses
EJ 15	+	+	+			+	+	+
JJ 16	+	Adds to model	Adds to model	Adds to model	Adds to model	Adds to model	Adds to model	Adds to model
JK 17	+	+	+			+		
MK 18	+			Adds to model	Adds to model	Adds to model	Adds to model	Adds to model
M'C 19	+	+			No Response		+	
M'D 20	+	+	+					

FIGURE I

BLOCK DESIGNS – COPY

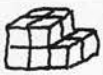
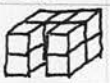
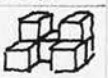
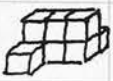
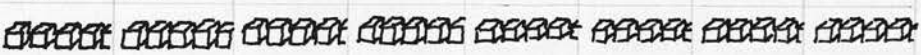
NAME	1	2	3	4	5	6	7	8
M'G 21	+	+	+	+	+		+	
M'Gi 22	Adds to model	Adds to model	Adds to model	Adds to model	Adds to model	Adds to model	Adds to model	Adds to model
M'L 23	+		+	+	+	+	+	
M'N 24	+	+	+	+	+	+	+	+
JM 25	+	+		+				
MM 26	+	+	+				+	
TN 27				No Response	No Response	No Response	No Response	No Response
MP 28	No Response	No Response	No Response	No Response	No Response	No Response	No Response	No Response
WP 29	+	+	+	+		+		
AP 30	+	+	+	+	+	+	+	+
Ri 31	+	+	+	+	+	+	+	+
ER 32	+	+	+	+	+	+		+
Si 33	+	+	Adds to model		+	+		+
ES 34	+	+	+	+	+	+	+	
AS 35	+			+	+		+	
EJ 36	+	+	+	+	+	+	+	+
BV 37	+		No Response	No Response	No Response	No Response	No Response	No Response
LV 38	+	+	+	+	+	+	+	+
TW 39				+				
MW 40								

FIGURE I

PLAIN BLOCK DESIGNS
REPRODUCTION FROM IMMEDIATE MEMORY

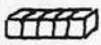
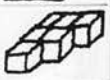
NAME	1	2	3	4	5	6	7	8
MA 1	+	+	+		+		+	
FA 2	Refuses	Refuses	Refuses	Refuses	Refuses	Refuses	Refuses	Refuses
Au 3	+	+			+			
FC 4					No Response	No Response	No Response	No Response
HC 5	No Response	No Response	No Response	No Response	No Response	No Response	No Response	No Response
EC 6	+	+		+				
Cu 7			Forget		Forget	Forget	Forget	Forget
Da 8	+		No Response	No Response	No Response	No Response	No Response	No Response
Du 9	+		Forget	Refuses	Refuses	Refuses	Refuses	Refuses
AF 10				+				
Ha 11	+	+				+	+	
IH 12	+	+	+	+	+	+	+	+
He 13			Forget	Forget	Forget	Forget	Forget	Forget
MH 14	No Response	No Response	No Response	No Response	No Response	No Response	No Response	No Response
EJ 15								+
JJ 16				No Response	No Response	No Response	No Response	No Response
JK 17	+					Forget		Forget
MK 18		Forget	Forget	Forget	Forget	Forget	Forget	Forget
M'C 19	+					No Response	No Response	No Response
M'D 20				Forget			No Response	No Response

FIGURE I

BLOCK DESIGN - IMMED. MEMORY

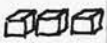
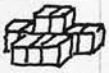
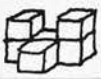
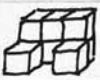
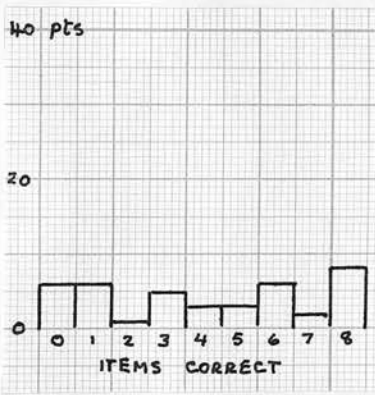
NAME	1	2	3	4	5	6	7	8
M'G 21				+		Forget		
M'Gi 22			Forget	Forget	No Response	No Response	No Response	No Response
M'L 23	+	+				No Response	No Response	No Response
M'N 24	+	+		+	+	+		
JM 25	+	+						No Response
MM 26	+				Forget	Forget	No Response	No Response
TN 27	No Response	No Response	No Response	No Response	No Response	No Response	No Response	No Response
MP 28	No Response	No Response	No Response	No Response	No Response	No Response	No Response	No Response
NP 29	+			+				Don't Know
AP 30	+	+		+	+	+	+	
Ri 31						+		
ER 32	+				+			
Si 33							Don't Know	Don't Know
ES 34	+	+		+	+		+	
AS 35						No Response	No Response	No Response
ET 36	+	+	+	+	+	+	+	
BV 37	No Response	No Response	No Response	No Response	No Response	No Response	No Response	No Response
LV 38	+			+	+	+	+	
TW 39				+				
MW 40	No Response	No Response	No Response	No Response	No Response	No Response	No Response	No Response

TABLE I

DISTRIBUTION OF CORRECT SCORES.

No. of correct responses	No. of Pts.	
	Copy.	Immed. Memory
8	8	1
7	2	1
6	6	1
5	3	4
4	3	1
3	5	2
2	1	4
1	6	10
0	6	16

COPYING



IMMED. MEMORY

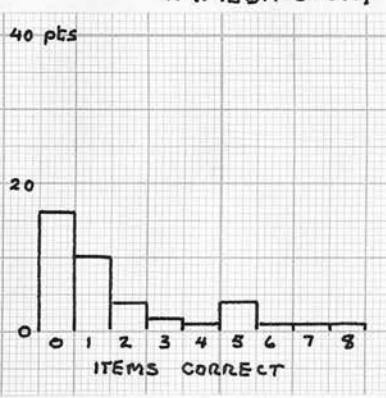


TABLE II

FREQUENCY OF CORRECT SCORES BY DESIGN

Test	Design							
	1	2	3	4	5	6	7	8
Copying	33	26	18	19	19	19	19	12
Immed. Memory	19	11	3	11	9	7	7	2

TABLE III

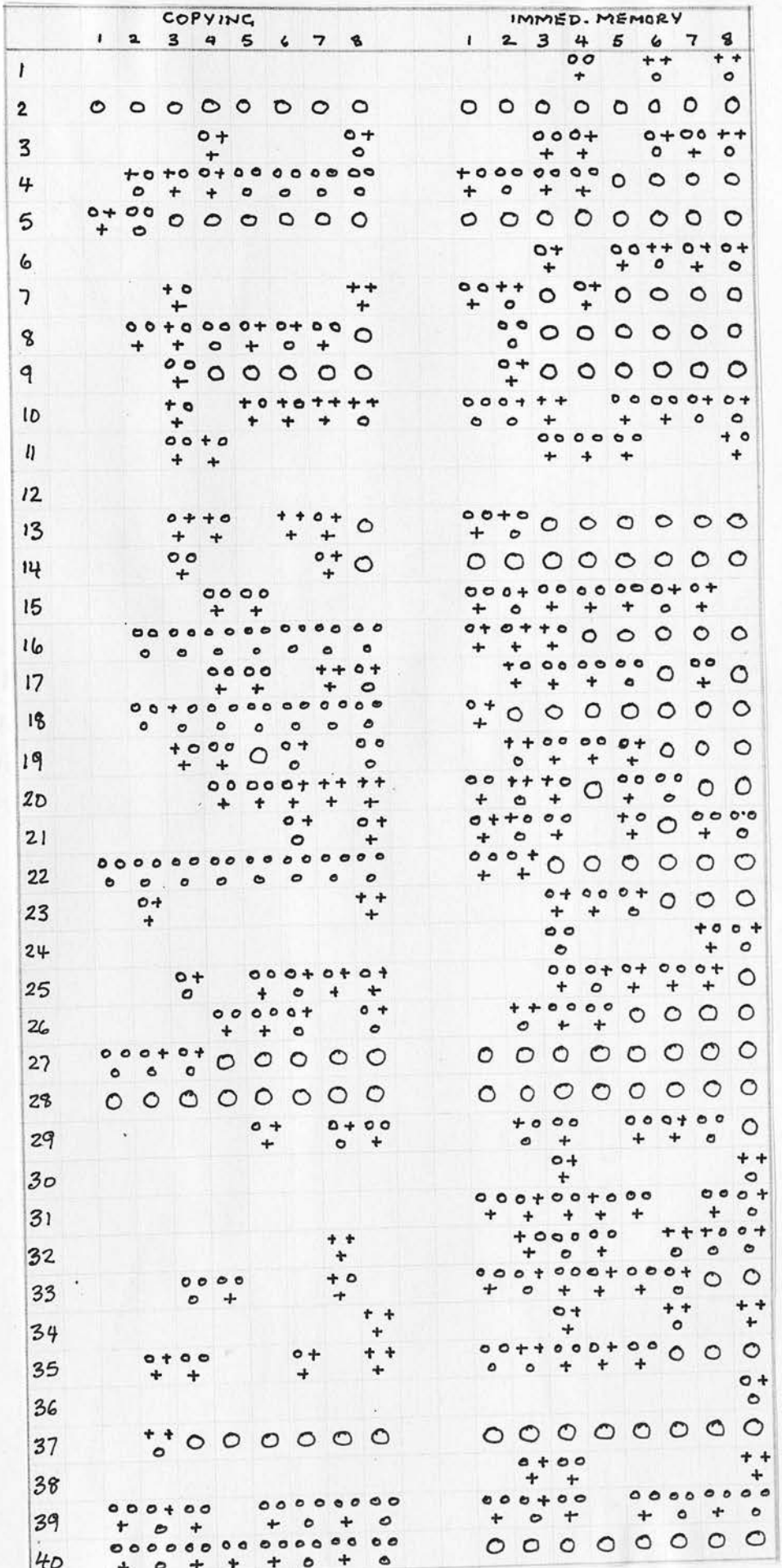

COPYING
1 2 3 4 5 6 7 8
IMMED. MEMORY
1 2 3 4 5 6 7 8
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40

TABLE IV

ITEM FACTORS

Factor	Design							
	1	2	3	4	5	6	7	8
Number of blocks	3	3	8	4	5	5	6	6
Dimension of Design	1	2	3	2	2	2	3	3
Symmetry (S) or Asymmetry (A)	S	A	S	S	S	A	S	A

TABLE V

FREQUENCY OF CORRECTLY PERFORMED FACTORS

Factor	Copying								Immed. Memory							
	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
Number	33	28	24	21	20	21	23	18	20	21	6	12	10	11	9	8
Dimension	35	31	21	21	21	27	26	23	23	25	8	16	12	15	11	13
Symmetry	36	29	30	30	29	23	29	20	31	18	25	25	22	10	16	5

TABLE VI

TYPE OF RESPONSE

Response	Copying								Immed. Memory							
	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
+	33	26	18	19	19	19	19	12	19	11	3	11	9	7	7	2
+/o	3	7	15	11	10	9	9	12	12	19	22	15	14	10	11	12
o	4	7	7	10	11	12	12	16	9	10	15	14	17	23	22	26

FIGURE Ic

PLAIN BLOCK DESIGNS — COPYING

ALL CORRECT

FIGURE I c

PLAIN BLOCK DESIGNS
REPRODUCTION FROM IMMEDIATE MEMORY

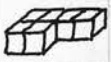
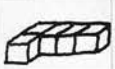
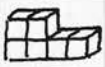
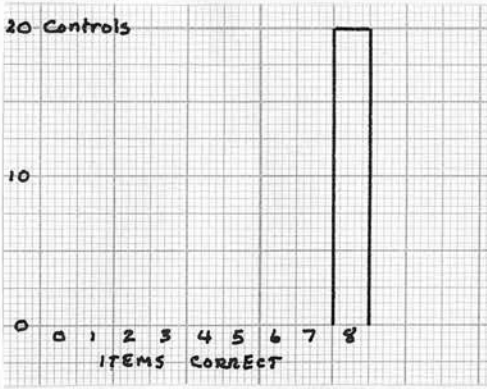
NAME	1	2	3	4	5	6	7	8
JB 1	+	+	+	+	+	+	+	+
AB 2	+	+	+	+	+	+		
BC 3	+	+	+	+	+	+	+	
JC 4	+	+	+	+	+	+	+	+
JD 5	+	+	+	+		+	+	
JE 6		+			+		+	
SF 7	+	+	+	+	+			+
AG 8	+			+	+			
RH 9	+	+	+	+			+	
SM'C 10	+	+	+	+	+		+	
PM'K 11	+	+	+	+	+	+	+	+
SM'L 12	+	+		+			+	+
AM'M 13	+	+	+	+	+	+	+	
JM 14	+	+		+	+	+	+	
JP 15	+	+	+	+	+	+	+	Forget
RP 16	+	+	+	+	+	+	+	
RPo 17	+	+	+	+		+		
AR 18	+	+	+	+	+	+	+	+
SR 19	+	+	+	+	+			
WW 20	+	+	+	+		+	+	

TABLE I[c]

DISTRIBUTION OF CORRECT SCORES

No. of correct responses	No. of controls	
	Copy	Immed. Memory
8	20	4
7	–	4
6	–	6
5	–	4
4	–	–
3	–	2
2	–	–
1	–	–
0	–	–

COPYING



IMMED. MEMORY

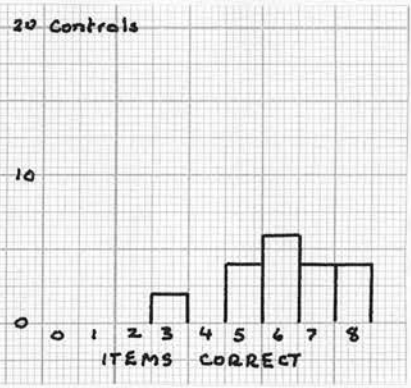


TABLE II[c]

FREQUENCY OF CORRECT SCORES BY DESIGN.

Test	Design							
	1	2	3	4	5	6	7	8
Copying	20	20	20	20	20	20	20	20
Immed. Memory	19	19	16	19	15	13	15	6

TABLE III[c]

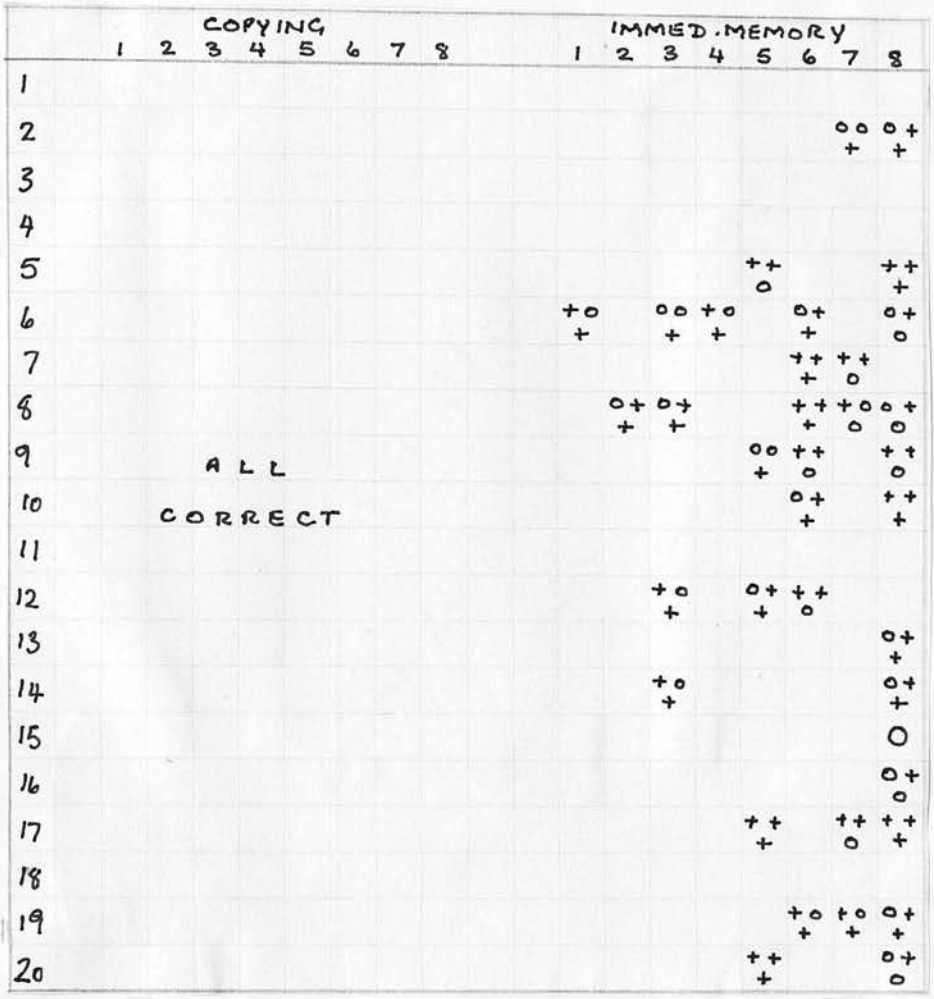


TABLE IV[c]

FREQUENCY OF CORRECTLY PERFORMED FACTORS

Factor	COPYING	IMMED. MEMORY							
		1	2	3	4	5	6	7	8
Number	ALL CORRECT	20	19	18	20	18	18	19	11
Dimension		19	20	17	19	19	19	17	19
Symmetry		20	20	20	20	19	18	17	13

TABLE V[c]

TYPE OF RESPONSE

Response	COPYING.								IMMED. MEMORY							
	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
+	20	20	20	20	20	20	20	20	19	19	16	19	15	13	15	6
+/o	-	-	-	-	-	-	-	-	1	1	4	1	5	7	5	13
o	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1

TEST 12.

K O H S' B L O C K S.

12. COPYING KOH'S BLOCKS FROM A PRINTED DESIGN.

Figures 1 and 1c show the responses to this test by patients and controls.

PATIENTS: Table 1 shows the distribution of correct scores. Only 1 patient constructs all 5 designs correctly and 25 out of 40 patients fail to copy any of the 5 designs correctly. Table 11 shows the frequency of correct responses by design. There is a progressive decline in the number of patients making correct responses as the test proceeds from Item 1 - 5. 15 correctly construct Design 1, while only 1 constructs Design 5 correctly.

PATIENT ERRORS. It is difficult to consider patient errors along the lines so far used; i.e. in terms of errors of gestalt and execution. It is clear on first examination of the responses that patients fail at an early stage in construction, viz. in the configuration of the block design (of 4 or 9 blocks) as distinct from the design upon the surface of the blocks (surface design). Table 111 considers this level of patient performance. The bottom rank shows the percentage of the patient group succeeding in the constructionof the block design of each item. It can be seen that this ranges from 57.5% in Item 1 to only 2.5% in Item 5.

Table 111 also shows that after Item 1, where there are 16 attempted, but faulty responses, there is a sudden drop to between 1 and 6 in the number of incorrect attempts.

Item 9 which has only 1 correct response, shows only 4 attempts. Though none of these has a correct block design, 3 of them in a way show the skeleton of the surface design.

Table 111 also shows that as the test proceeds from Item 1 - 5 the frequency of "no response" increases from 10 in Item 1 to 35 in Item 5;

the sharpest increase being between Items 1 and 2.

SUMMARY OF PATIENT RESPONSES.

1. Level of correct scoring in this test is very low. There is a progressive decline in the number of patients performing items correctly as the test proceeds from Item 1 to 5.

2. When the test is considered as a plain block design test, patient performance is still poor. 57.5% succeed in this aspect of Item 1, and only 2.5% in Item 5.

3. In Items 2 - 5 patients show a tendency to perform correctly or not at all.

CONTROLS.

Table 1c shows the distribution of correct scores. 8 subjects out of 20 construct all designs correctly. No subject fails to construct any design correctly. Table 11c shows the frequency of correct scores by design. There is progressive decline in the number of control subjects making correct responses as the test proceeds from Item 1 - 5. All subjects correctly construct Design 1, while only 9 construct Design 5 correctly.

CONTROL ERRORS. Table 111c corresponds to Table 111 (patients). The bottom rank shows that between100% in Item 1 and 70% in Item 5 succeed in the construction of the block design.

Where there are errors the item has usually been attempted. Only in Item 5 is there any appreciable number of "no response".

SUMMARY OF CONTROL RESPONSES.

1. 8 out of 20 controls have maximum possible scores. No subject fails all 5 items. There is a progressive decline in the number of controls performing items correctly as the test proceeds from Item 1 to 5

2. Considered as a plain block design test, 100% of controls succeed in Item 1 and 70% in Item 5.

PATIENT-CONTROL CONTRAST.

1. The distribution of correct scores is quite different in the two groups. "0" responses are most frequent in patients. Wholly correct response is most frequent in controls.

2. Both groups show a severe drop in the frequency of correct response as the test proceeds from Item 1 - 5.

3. In patients' errors "no response" forms the greater proportion of responses. In controls they occur appreciably only in Item 5.

4. Considered as a plain block design test, the item (1) performed best by the patient group does not reach the level of performance of the item (5) performed worst by the control group.

5. Patients show a tendency to perform correctly or not at all in Items 2 - 5. There is no such tendency among controls.

FIGURE I

KOHS' BLOCKS

NAME	1	2	3	4	5
MA 1	+	+	+	+	
FA 2	+	+	Arranges in a row	–	–
Au 3		–	–	–	–
FC 4		–	–	–	–
HC 5		–	–	–	–
EC 6	+	Fingers blocks at random	–	–	–
Cu 7	+	 i ii	 i ii iii	–	–
Da 8		–	–	–	–
Du 9	+		–	–	–
AF 10		–	–	–	–
Ha 11		–	–	–	–
IH 12	+	+	+	+	
He 13	Fingers blocks at random	–	–	–	–
MH 14	Fingers blocks at random	–	–	–	–
EJ 15	+	+	+	+ After much trial & error	
JJ 16		–	–	–	–
JK 17	 + ii	–	–	–	–
MK 18	–	–	–	–	–
M'C 19	Fingers blocks at random	–	–	–	–
M'D 20	+	Don't Know	–	–	–

FIGURE I

KOHS' BLOCKS

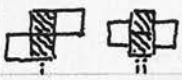
NAME	1	2	3	4	5
M'G 21	—	—	—	—	—
M'Gi 22	counts blocks only	—	—	—	—
M'L 23	 i ii iii	—	—	—	—
M'N 24	+				—
JM 25		—	—	—	—
MM 26			—	—	—
TN 27	—	—	—	—	—
MP 28	—	—	—	—	—
WP 29		—	—	—	—
AP 30	+	 + i ii	+ After much trial & error	+ After much trial & error	
Ri 31	+		+	—	—
ER 32	+	+		—	—
Si 33		Don't Know	—	—	—
ES 34		Don't Know	—	—	—
AS 35	 i ii	—	—	—	—
ET 36	+	+	+	+	+
BV 37	—	—	—	—	—
LV 38	+	+	 i ii iii	—	—
TW 39		—	—	—	—
MW 40	—	—	—	—	—

TABLE I
DISTRIBUTION OF CORRECT SCORES

No. of correct responses	No. of Pts.
5	1
4	4
3	0
2	4
1	6
0	25

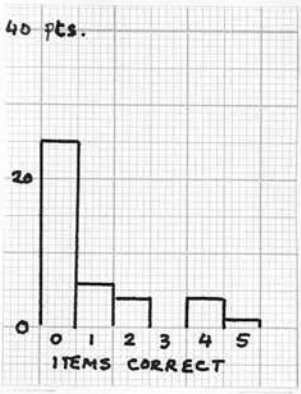


TABLE II
FREQUENCY OF CORRECT SCORES BY DESIGN

	Design				
	1	2	3	4	5
No. of patients	15	8	6	5	1

TABLE III
ERRORS

Response	Design				
	1	2	3	4	5
Wholly correct	15	8	6	5	1
Block design only correct	8	4	4	0	0
Block design wrong	8	2	1	1	4
No effort	10	26	29	34	35

FIGURE I^c

KOHS' BLOCKS

NAME	1	2	3	4	5
JB 1	i ii	+			—
AB 2	+	i ii + iii	i ii iii	i ii	—
BC 3	+	+	+	+	
JC 4	+	+	+	+	+
JD 5	+	+	+	+	+
JE 6	+	+	+	+	
SF 7	+	+	+	+	
AG 8	+	+	+	+	+
RH 9	+			—	—
SM'C 10	+	+	+	+	+ After much trial & error
PM'K 11	+	+	+	+	+
SM'L 12	+	i + ii	+	+	
AM'M 13	+	+	+	+	
JM 14	+	i ii	i ii iii	—	—
JP 15	+	+	+	+	+ ii
RP 16	+	+	+	—	—
RPo 17	+	+	+	+	+
AR 18	+	+	—		+
SR 19	+		+ After much trial & error		—
WW 20	+	+	+	+	+

TABLE I^{c}

DISTRIBUTION OF CORRECT SCORES.

No. of correct responses	No. of controls
5	8
4	5
3	2
2	3
1	2
0	0

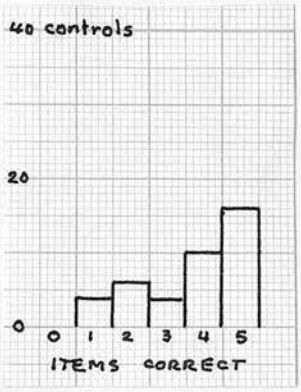


TABLE II^{c}

FREQUENCY OF CORRECT SCORES BY DESIGN

	Design				
	1	2	3	4	5
No. of controls	20	17	15	13	9

TABLE III^{c}

ERRORS

Response	Design				
	1	2	3	4	5
Wholly correct	20	17	15	13	9
Block design only correct	–	2	1	2	5
Block design wrong	–	1	3	2	–
No effort	–	–	1	3	6

TEST 13.

COPYING STICKS IN PLASTICINE.

13. COPYING STICKS IN PLASTICINE.

Figures 1 and 1c show the responses to this test by patients and controls.

PATIENTS. Table 1 shows the distribution of correct scores. No patient copies all 10 designs correctly. The best score is 8 out of 10, achieved by 2 patients only. 14 patients fail to copy any item correctly. Table 11 shows the frequency of correct responses by design. A glance suggests a progressive decline in the frequency from Design 1 to 10. The exception to this trend is Design 9. The design showing the highest number of correct responses is the first, which is correctly constructed by 26 out of 40 patients. Design 10 is not constructed correctly by any patient. Design 9 is constructed correctly by 14.

PATIENT ERRORS. The consideration of errors in this test cannot conform to the pattern used in previous tests where success in execution and the portrayal of gestalt have been the standards. In sticks in plasticine deviation from these standards may well occur, but it would be difficult to devise for this test criteria which are comparable with those defined for "E" errors and "G" errors in other tests.

Two factors will be considered in analysing the incorrect responses in this test.

1. REDUCTION TO SYMMETRY. This is a response in which the faulty positioning of sticks has been such as to create a design which is symmetrical about the median sagittal plane of the plasticine ball. Table 111 shows the frequency with which responses of this kind occur in each item; i.e. most frequently in Designs 3, 8 and 10, and least in Designs 1, 4 and 5. Such a response cannot occur in Design 9 which is already

symmetrical about the plane described.

2. DISORIENTATION OF STICKS. The position of sticks in this test can be distinguished according to whether they should be vertically, horizontally or diagonally orientated. In Table 1V only those patients who have attempted the task but failed to achieve a wholly correct response have been considered. The figures in the table show in each item the number of patients who have placed a stick in correct orientation over the number of patients who have attempted but failed to construct the whole item correctly. This should give some indication of the relative success achieved by patients in placing vertical horizontal and diagonally orientated sticks. Table V shows these figures as a percentage of those who attempt but fail each item as a whole, and shows a mean percentage for the diagonally orientated sticks of which there are of course more than 1 in 4 items. The bottom rank of Table V shows a mean percentage success for each orientation.

This table shows, even in those items which are attempted but failed, that vertically orientated sticks are nevertheless placed correctly on the whole (mean correct placing 71.6%). This is not the case for horizontally and diagonally orientated sticks. The latter are placed correctly least often (mean correct placing 21.2%). Horizontally orientated sticks occupy an intermediate scoring position (mean correct placing 34.7%).

SUMMARY OF PATIENT RESPONSES.

1. The frequency of correct scoring is low. Only 2 patients score 8 items out of 10 correctly. 14 patients fail to copy any item correctly.

2. The first 3 items and Item 9 are most often constructed correctly.

3. The commonest identifiable error is one designated, reduction to symmetry. It occurs most commonly in Items 3, 8 and 10 and least

in Items 1, 4 and 5.

4. Patients who attempt items but fail to construct them correctly nevertheless succeed to a large extent in placing correctly the sticks in these items which should be vertically orientated while failing most severely to place sticks which should be diagonally orientated. The placing of sticks which should be horizontally orientated occupies a scoring position in these items which is intermediate.

CONTROLS.

Table 1c shows the distribution of correct scores. 3 subjects out of 20 achieve fully correct scores. No subject fails all designs. The lowest score is 4 out of 10.

Table 11c shows the frequency of correct responses by design. There is a progressive decline in the correct responses as the test proceeds from Item 1 (all correct) to Item 10 (4 correct). Item 9 does not fit this trend.

CONTROL ERRORS.

1. REDUCTION TO SYMMETRY. Table 111c shows the frequency of responses of this kind. They are most frequent in Designs 8 and 10, and rare or non-existent in the rest.

2. DISORIENTATION OF STICKS. Tables 1Vc and Vc correspond to Tables 1V and V devised for patients. Those controls who attempt but fail to construct items as a whole, nevertheless largely succeed in placing sticks which should be vertically orientated (mean correct placing 86.6%). Diagonally orientated sticks are placed with least success (mean correct placing 28.1%) and horizontally orientated sticks occupy an intermediate scoring position (mean correct placing 57.2%).

SUMMARY OF CONTROL RESPONSES.

1. 3 control subjects achieve maximum scores. None scores less than 4 out of 10.

2. The first 3 items and Item 9 are most often constructed correctly.

3. Reduction to symmetry occurs in Items 8 and 10 but is rare otherwise.

4. Control subjects who attempt items but fail to construct them correctly nevertheless succeed to a large extent in placing correctly the sticks in these items which should be vertically orientated, while failing to place sticks which should be diagonally orientated. Sticks which should be horizontally orientated achieve intermediate success.

PATIENT-CONTROL CONTRAST.

1. There is a marked difference between the two groups in the distributions of correct scores.

2. In both groups the first 3 items and Item 9 are most often correctly constructed.

3. "Reduction to symmetry" occurs much more commonly in patients than controls, though in the latter it is very frequent in Items 8 and 10.

4. Both patients and controls show the same pattern of error when wrongly constructed items only are considered. The vertical elements of these items are well placed. It is the diagonal elements which are the greatest source of error with horizontally orientated sticks occupying an intermediate position.

FIGURE I

STICKS IN PLASTICINE

NAME	1	2	3	4	5	6	7	8	9	10
MA 1	+	+	+		+			Refuses	Refuses	Refuses
FA 2	Refuses	Refuses	Refuses	Refuses	Refuses	Refuses	Refuses	Refuses	Refuses	Refuses
Au 3	+			+						
FC 4					No Response	No Response	No Response	No Response	No Response	No Response
HC 5				No Response	No Response	No Response	No Response	No Response	No Response	No Response
EC 6	+	+	+	+	+				+	
Cu 7	+	+	+			+		No change from 7	No change from 7	No change from 7
Da 8	+							No change from 7	+	No change from 7
Du 9	+	+	+	+	+					
AF 10		Don't Know	Don't Know	Don't Know	Don't Know	Don't Know	Don't Know	Don't Know	Don't Know	Don't Know
Ha 11	+	+	+		+				+	Don't Know
IH 12	+	+	+	+	+	+	+		+	
He 13	+	+						Refuses	Refuses	Refuses
MH 14	Refuses	Refuses	Refuses	Refuses	Refuses	Refuses	Refuses	Refuses	Refuses	Refuses
EJ 15	+	+		+		+	+		+	
JJ 16	No Response	No Response	No Response	No Response	No Response	No Response	No Response	No Response	No Response	No Response
JK 17	+		+	+					+	
MK 18	No Response	No Response	No Response	No Response	No Response	No Response	No Response	No Response	No Response	No Response
M'C 19				Don't Know	Don't Know	Don't Know	Don't Know	Don't Know	Don't Know	Don't Know
M'D 20	+		Don't Know	Don't Know	Don't Know	Don't Know	Don't Know	Don't Know	Don't Know	Don't Know

FIGURE 1

STICKS IN PLASTICINE

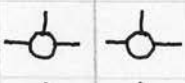
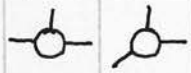
NAME	1	2	3	4	5	6	7	8	9	10
M'G 21			No Response	No Response	No Response	No Response	No Response	No Response	No Response	No Response
M'Gi 22	Refuses	Refuses	Refuses	Refuses	Refuses	Refuses	Refuses	Refuses	Refuses	Refuses
M'L 23				Don't Know	Don't Know	Don't Know	Don't Know	Don't Know	Don't Know	Don't Know
M'N 24	+	+			+	+			+	
JM 25	+						+		+	
MM 26	+					Don't Know	Don't Know	Don't Know	Don't Know	Don't Know
TN 27	No Response	No Response	No Response	No Response	No Response	No Response	No Response	No Response	No Response	No Response
MP 28	+	+					Refuses	Refuses	Refuses	Refuses
WP 29	+	+				Refuses	Refuses	Refuses	Refuses	Refuses
AP 30	+	+		+	+	+	+	+	+	
Ri 31	+	+	+		+				+	Refuses
ER 32	+	+	+		+	+				
Si 33	+	+		+					+	
ES 34	+								+	
AS 35	+	+					No Response	No Response	No Response	No Response
ET 36	+	+	+						+	
BV 37	No Response	No Response	No Response	No Response	No Response	No Response	No Response	No Response	No Response	No Response
LV 38	+	+							+	No Response
TW 39	+						+			
MW 40				No Response	No Response	No Response	No Response	No Response	No Response	No Response

TABLE I

DISTRIBUTION OF CORRECT SCORES

No. of correct responses	No. of Pts.
10	–
9	–
8	2
7	–
6	2
5	5
4	5
3	2
2	8
1	2
0	14

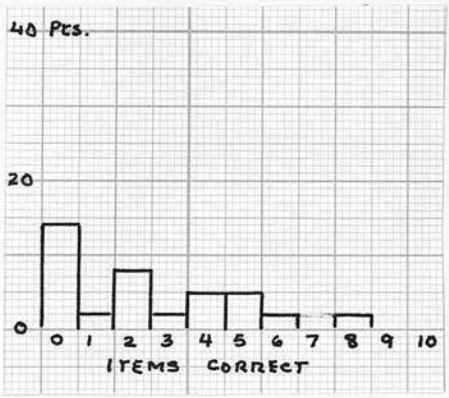


TABLE II

FREQUENCY OF CORRECT SCORES BY DESIGN

Design	1	2	3	4	5	6	7	8	9	10
No. of patients	26	18	10	8	9	6	5	1	14	–

TABLE III

ERRORS – REDUCTION TO SYMMETRY

Design	1	2	3	4	5	6	7	8	9	10
No. of patients	1	8	13	5	4	8	6	11	–	11

TABLE IV

ERRORS – DISORIENTATION OF STICKS

Design	VERTICAL	HORIZONTAL	DIAGONAL		
			1	2	3
1	3/7	2/7	–	–	–
2	13/14	4/14	8/14	–	–
3	16/20	12/20	0/20	–	–
4	14/18	4/18 9/18	–	–	–
5	15/17	7/17	2/17	–	–
6	14/17	7/17	1/17	–	–
7	6/16	–	2/16	4/16	–
8	–	–	5/17	5/17	3/17
9	–	–	0/5	0/5	0/5
10	–	1/16	6/16	10/16	–

TABLE V

ERRORS – DISORIENTATION OF STICKS

Design	VERTICAL	HORIZONTAL	MEAN DIAGONAL
1	42·8	28·6	–
2	92·9	28·6	57·7
3	80·0	60·0	0·0
4	77·7	22·2 2·5	–
5	88·2	41·2	11·7
6	82·3	41·2	5·9
7	37·5	–	18·7
8	–	–	25·5
9	–	–	0·0
10	–	6·2	50·0
Mean %	71·6	34·7	21·2

FIGURE Ic

STICKS IN PLASTICINE

NAME	1	2	3	4	5	6	7	8	9	10
JB 1	+	+	+	+	+	+	+	+	+	+
AB 2	+	+	+	+	+	+	+	+	+	+
BC 3	+	+	+	+	+	+	+	+	+	+
JC 4	+	+	+	+	+	+	+	+	+	+
JD 5	+	+	+	+	+	+	+	+	+	+
JE 6	+	+	+	+	+	+	+	+	+	+
SF 7	+	+	+	+	+	+	+	+	+	+
AG 8	+	+	+	+	+	+	+	+	+	+
RH 9	+	+	+	+	+	+	+	+	+	+
SM'C 10	+	+	+	+	+	+	+	+	+	+
PM'K 11	+	+	+	+	+	+	+	+	+	+
SM'L 12	+	+	+	+	+	+	+	+	+	+
AM'M 13	+	+	+	+	+	+	+	+	+	+
JM 14	+	+	+	+	+	+	+	+	+	+
JP 15	+	+	+	+	+	+	+	+	+	+
RP 16	+	+	+	+	+	+	+	+	+	+
RPo 17	+	+	+	+	+	+	+	+	+	+
AR 18	+	+	+	+	+	+	+	+	+	+
SR 19	+	+	+	+	+	+	+	+	+	+
WW 20	+	+	+	+	+	+	+	+	+	+

TABLE I[c]

DISTRIBUTION OF CORRECT SCORES

No. of Correct responses	No. of Controls
10	3
9	3
8	4
7	4
6	2
5	2
4	2
3	—
2	—
1	—
0	—

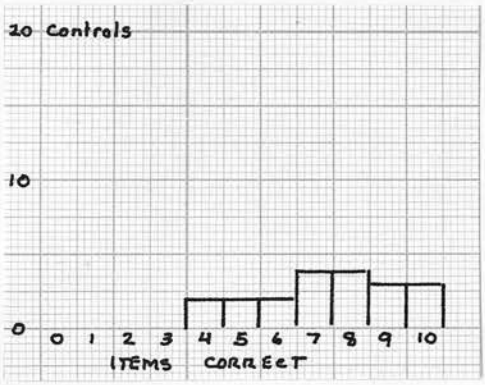


TABLE II[c]

FREQUENCY OF CORRECT SCORES BY DESIGN

Design	1	2	3	4	5	6	7	8	9	10
No. of patients	20	18	18	17	15	15	10	10	20	4

TABLE III[c]

ERRORS — REDUCTION TO SYMMETRY

Design	1	2	3	4	5	6	7	8	9	10
No. of patients	—	—	1	1	—	—	4	8	—	11

TABLE IV^c

ERRORS – DISORIENTATION OF STICKS

Design	VERTICAL	HORIZONTAL	DIAGONAL		
			1	2	3
1	—	—	—	—	—
2	2/2	2/2	0/2	—	-
3	2/2	1/2	0/2	—	—
4	3/3	0/3	2/3	—	—
5	4/5	4/5	0/5	—	—
6	5/5	4/5	1/5	—	—
7	4/10	—	8/10	3/10	-
8	-	—	9/10	1/10	5/10
9	-	—	-	—	—
10	—	0/16	10/16	13/16	-

TABLE V^c

ERRORS – DISORIENTATION OF STICKS

Design	VERTICAL	HORIZONTAL	MEAN DIAGONAL
1	—	—	—
2	100	100	0
3	100	50	0
4	100	33	—
5	80	80	0
6	100	80	20
7	40	—	55
8	—	—	50
9	—	—	—
10	—	0	72
MEAN %	86·6	57·2	28·1

COLLECTED RESULTS.

The consideration of individual tests is now complete, and it is now proposed to consider the 13 tests as a group in relation to individual subject performance.

Table 1 shows a general estimate of performance by the 20 controls in terms of the success achieved by them in performing the tests. Success "+" has been judged here as a raw score which is as great as, or exceeds the mean of the whole control group in any test. Where this level has not been achieved no entry is made on the table. In the bottom rank of this table each subject's total of tests correctly performed by this criterion, appears. It ranges from 4 out of 13 to 13 out of 13. The distribution is shown on Table 11 which shows that all but 4 of the series have totals of "+" scores in between 6 and 10 out of 13.

Table 111 is a general estimate for patients whose success "+" in performing a test is judged in terms of a raw score which is as great as, or exceeds the mean of the whole control group in its performance of that test. The bottom rank of this table shows each patient's total of tests correctly performed by this criterion. The distribution of these totals is shown in Table 1V, where all but 6 patients achieve totals between 0 to 5 out of 13. 6 patients, in other words, achieve totals of correctly performed tests which, in respect of raw scores, correspond with the level of performance of the control group as a whole.

There appears to be therefore a sub-group within the patient series which can be said to perform visuo-constructive tasks as well as their healthy contemporaries.

Table V shows an analysis of the errors described in terms of "G", "E", "+", "N" of these 6 patients. Table V1 analyses the errors of 6 control subjects; comparable in respect of their number of correctly

performed tests. The frequency of "E" errors in both groups is almost identical. The frequency of combined "G" + "GE" + "N" errors is, on the other hand slightly greater among patients than controls. In only one test is this difference marked. The errors in Koh's blocks in controls are all executive. In patients however 3 of the 6 show "G" or "N" errors.

The mean age of this small group of patients is 77.33 years which does not differ from the mean age of the patient group as a whole.

The length of the senile process from reported time of onset to time of present examination is 23 months for the small group, compared with 40 months for the patient group as a whole.

There is 1 male among the 6 patients in the small group, compared with 8 in the patient group as a whole.

The small group therefore varies little or not at all in respect of age and sex, from the whole patient group, and only slightly in respect of errors of gestalt and length of process from comparable subjects in the control group.

The next matter for consideration is the comparative order of difficulty which the tests present to the two groups. Table V11 gives detail of the number of items constructed correctly by the patient group and by the control group in each test. These figures are also shown as a percentage of the possible maximum score in the case of each test. The extreme right-hand column in the table shows the difference between patients and controls in these percentage scores.

Below Table V11 the tests are listed in rank order. The first test in each rank being the one in which the percentage of items correctly performed is greatest and the last being the one in which the number of items correctly performed by each group is least.

These two lists are arbitrarily divided into three sections.

1. Where the percentage is between 66 - 100%

11. Where the percentage is between 33 - 66%

111. Where the percentage is between 0 - 33%

The patient list shows that the tests in Sections 1 and 11 consist, with the exception of "copying plain block designs", of items which contain for construction, simple geometrical figures, i.e. designs which are irreducible (except to straight and curved lines), familiar, and can be named in one word. The group of tests in Section 111 contain items which are on the whole not simple according to these standards. The list shows that there is only 1 test in Section 1, 4 in Section 11 and 8 in Section 111.

The control list shows that, in Section 1 there are both simple and complex tests. These are 9 in number. In Sections 11 and 111 there are respectively 3 and 1 test.

The last (worst) three tests in each list are the same. (viz. Abelson's drawing house, man, etc. and reproduction from immediate memory of Bender-Gestalt).

The tests which show the greatest discrepancy in performance between the two groups as a whole are in order as follows:- Mannikin, spontaneous construction of match designs, reproduction of plain block designs from immediate memory, construction of plasticine sticks, copying plain block designs, Koh's blocks and spontaneous drawing of simple geometrical designs.

The difference in performance is not great in the remaining tests and in particular in the case of drawing house, man, etc., copying matchstick designs, and copying simple geometrical designs.

TABLE I

TEST	CONTROL CASES 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1			+		+	+	+			+	+			+	+	+	+	+		+
2		+	+			+	+		+	+					+		+	+		
3		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
4	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+
5						+			+	+	+				+			+		+
6		+			+					+	+		+	+	+			+		+
7	+				+		+	+		+	+	+	+	+	+	+				+
8		+	+		+		+	+	+		+		+	+	+					+
9	+		+	+	+	+	+	+		+	+	+	+		+	+	+	+	+	+
10	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
11	+		+	+							+		+		+	+		+		
12			+	+	+	+	+	+		+	+	+	+		+		+			+
13	+			+			+	+			+	+		+	+	+		+		+
No. of Tests performed.	6	6	9	7	9	8	10	7	6	10	12	7	8	8	13	8	7	10	4	11

TABLE II

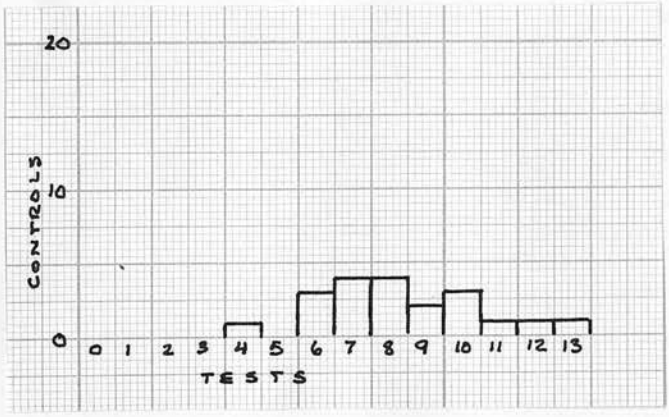


TABLE III

TEST	PATIENT CASES 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
1															+														+	+								+		
2	+		+									+			+									+		+			+	+			+	+				+		
3	+											+			+										+				+	+	+	+		+		+		+		
4	+		+			+	+	+	+	+	+	+	+		+	+	+			+				+	+	+			+	+	+	+	+	+	+			+		
5																								+						+								+		
6																								+						+										
7															+									+										+		+				
8		+										+			+								+	+		+				+	+							+		
9							+				+	+			+										+					+						+				
10	+					+						+												+						+	+					+		+		
11												+																								+				
12	+											+			+															+						+				
13																														+										
No. of tests performed.	5	1	2			2	2	1	1	1	2	8	1		8	1	1			1			1	7	3	3			4	11	4	2	2	4	1	7		7		

TABLE IV

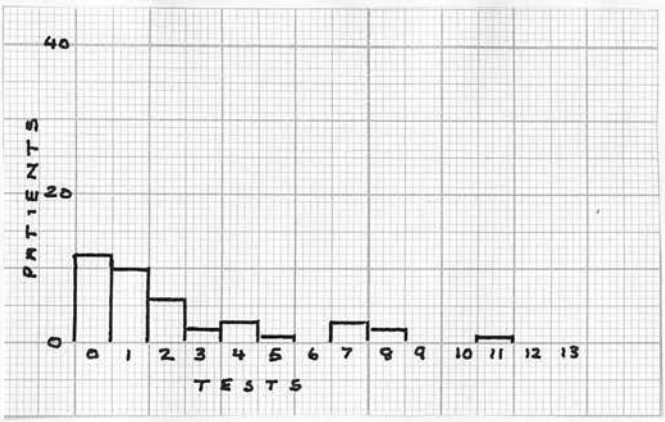


TABLE V

ERRORS OF SIX 'SUPERIOR' PATIENTS

Response	Patient					
	Pt. 30	Pt. 12	Pt. 15	Pt. 24	Pt. 36	Pt. 38
Correct	48	33	35	29	28	28
G	2	4	1	8	4	3
E	7	12	15	14	15	16
GE	–	1	1	–	5	1
N	–	2	–	1	–	3
G+GE+N	2	7	2	8	9	7
E	7	12	15	14	15	16

TABLE VI

ERRORS OF SIX MATCHED CONTROLS

Response	Control					
	1	2	3	4	5	6
Correct	43	33	35	30	33	34
G	1	5	3	1	1	2
E	8	13	14	18	17	15
GE	–	1	1	2	1	–
N	–	–	–	1	–	1
G+GE+N	1	6	4	4	2	3
E	8	13	14	18	17	15

TABLE VII

TOTAL NUMBER OF ITEMS PERFORMED CORRECTLY

Test	Patients		Controls		% difference between patients and controls
	Raw Score	% Score	Raw Score	% Score	
1. Geometrical Figs. – spont.	88	44%	87	87%	43
2. " " – copy.	110	55%	81	81%	26
3. Matchsticks – spont.	47	39%	59	98%	59
4. " – copy.	96	80%	59	98%	18
5. Abelson's Figs.	22	11%	41	41%	30
6. Bender-Gestalt – copy.	65	18%	86	48%	30
7. " " – Immed. Mem.	2	2.5%	15	37%	34.5
8. Draw House, Man, etc.	12	7.5%	15	19%	11.5
9. Mannikin	7	17.5%	17	85%	67.5
10. Block design - copy	164	51%	160	100%	49
11. " " - Immed. Mem.	69	22%	122	76%	55
12. Kohs' Blocks.	60	30%	74	74%	44
13. Plasticine sticks	96	24%	147	73%	49

PATIENTS

I
1. MATCHSTICKS – COPY.

II
2. GEOM. FIGS. – COPY.
3. BLOCK DESIGNS – COPY.
4. GEOM. FIGS. – SPONT.
5. MATCHSTICKS – SPONT.

III
6. KOHS'
7. PLASTICINE STICKS
8. BLOCK DESIGN – IMMED. MEM.
9. BENDER-GESTALT – COPY.
10. MANNIKIN
11. ABELSON'S
12. DRAW HOUSE, ETC.
13. BENDER-GESTALT – IMMED. MEM.

CONTROLS

I
1. BLOCK DESIGN – COPY
2. MATCHSTICKS – SPONT.
3. MATCHSTICKS – COPY.
4. GEOM. FIGS – SPONT.
5. MANNIKIN.
6. GEOM. FIGS – COPY.
7. BLOCK DESIGN – IMMED. MEM.
8. KOHS'
9. PLASTICINE STICKS

II
10. BENDER-GESTALT-COPY
11. ABELSON'S
12. BENDER-GESTALT-IMMED. MEM.

III
13. DRAW HOUSE, ETC.

DISCUSSION.

DISCUSSION.

It is common practice in discussing the designs constructed by patients performing tests of the kind described above, to consider the task involved as having two major aspects; that is an act of visual perception going on in some form of association with motor activity. The task is being performed under visual (and possibly tactile) control.

In copying it might be assumed that on the basis of the given instructions the subject peruses the model with a view to reproducing it through motor activity. Some form of analysis may occur in these circumstances, whereby the subject sees his way to creating a reproduction of the whole design from a collection of fragments and through a sequence of incomplete forms. The fragments may be already there in the form of matchsticks or wooden blocks, or the fragments themselves may have to be created, as they are in all drawing tests. This planning must in the first place precede the onset of motor activity, but may also continue after response has begun.

In other tests - those of reproduction from immediate memory - where preceding perception must occur, any analysis of the model design under direct vision must take place entirely before motor activity begins. This is the case in tests where reproduction from immediate memory is asked for. If in these circumstances visual reference to a model occurs while motor action is going on the reference can only be to an image of the model.

What processes occur when spontaneous construction is asked for is difficult to speculate upon. The extent to which this kind of task can be investigated is limited because the design of the required structure must be one which is familiar visually, and one whose verbal description represents something unambiguous.

This reduces the range of objects which can be constructed under this condition to simple geometrical shapes, and to objects within a broad category, like house, man, tree and bicycle. Complex designs like those in the Bender-Gestalt or Abelson's series must be excluded, by reason of the unfamiliarity of some of the component parts of the designs, and by virtue of the complexity of the spatial relationships that exist between their parts. These relationships could be described in language only at great length and even then the nature of the required design could not be as precise as when that design is displayed in a model for direct copying. It must therefore be considered in what way perception is involved in tests demanding construction of simple and familiar designs on verbal instruction. That they are simple and familiar implies that their perception or construction has been frequent in the past and that their construction under current test conditions may therefore take place automatically, rote-fashion, without reference to a visual image. While this may be true of simple geometrical shapes, one might expect the drawing of objects like house, man, tree and bicycle to have to take place under the guidance of visual imagery. Were this so, the drawer would be almost compelled to give representations of these objects, which corresponded closely in relative dimensions with real objects, conjured up from individual experience. If on the other hand these objects were drawn without reference to imagery they might show signs of the automatic motor activity just referred to.

The assumption that both motor and perceptual acts are involved in the whole process of constructional ability seems well justified. There must be some reservation however about the extent to which these aspects of constructional performanee

can be discretely identified in response. It is manifestly true that the responses to these tests constitute a record, but the record may be an end product of a variety of different kinds of process, which include direct visual perception, or imagery, analysis and planning and the manipulation of objects in space. The extent to which one can identify, from the structure produced by the subject, perceptual and planning failures, as distinct from failures in motor function, is in doubt. It remains a fact that what the examiner observes during performance or in the completed responses is motor activity. Other things must be inferred.

The responses of the present series have in most cases been reviewed in terms of the success with which they do, or do not, show signs of what has been called executive ability, and ability to portray a gestalt. The reasons for this kind of broad distinction are as follows. From faulty responses two major types of defect can be identified, and these can at times exist independently of one another. Responses occur which portray a gestalt which corresponds with that of the model, but whose execution reveals striking defect of detail. Conversely, responses occur where there has been some degree of failure to portray gestalt; the faulty design has however been executed correctly. A faulty response can show both failure in the portrayal of gestalt and a defect in executing the faulty design.

Another reason for the chosen subdivision is that they get close to the factors described above as being concerned in the process of construction. However, though they approximate, they do not precisely correspond with the two main limbs involved in construction. Ability to convey gestalt is not the same as perceptual ability, and what has been repeatedly defined in

results as executive ability is not the same as motor ability. It seems probable that the complexity of visual perception as a process depends not only upon the complexity of the design but also upon the nature of the evidence the subject is required to give that perception has occurred. If the subject is required to name in evidence an object perceived, then, as already discussed, the nature of the designs determine whether a single-word answer suffices to convey the familiar class of perceived object (e.g. square) or whether a lengthy, complex verbal description inadequately conveys the special, perceived object (e.g. an item of the Bender Gestalt series). Giving the name "square" as evidence of that figure's perception, may well need a quality of analysis and planning which differs from that required when the evidence asked for is constructed reproduction of the same design. Verbal response is symbolic; constructed response is not. That a symbolic response suffices as evidence of "good" perception informs the listener that the design as a whole form has been recognised as belonging to a class of objects, viz. square. It does not convey either the special features of the particular perceived square (e.g. its size) or whether the perceiver is capable of making an analysis of the form revealing some understanding of its design; that it has right angles, four in number; that it has straight lines of a certain, equal length, and that it is orientated in a special way in relation to the page upon which it is drawn. Accurate <u>drawing</u> of a square does reveal this quality of understanding in the perceiver. Perception in the first instance (naming) may be merely recognition. In the second instance (construction) perception is seen to extend beyond recognition, revealing evidence of minute analysis of the nature of the structure of the particular perceived form.

Whether one considers analysis as a part of perception or as the first stage of the process of execution is perhaps a matter of choice. This investigation has chosen to group the analysis referred to with executive activity; e.g. distortion of angles, rotation of components and of the whole design have been referred to as executive errors throughout. It must therefore follow that perception in this study has the restricted meaning, discussed above, of recognition of form.

Where responses are wholly correct in copying tests one can say with confidence that perception and motor function are operating intact.

Where response is wholly correct in the tests requiring spontaneous construction, perception is not of an environmental stimulus, but must depend on earlier experience of the object named. Doubt about the extent to which imagery is involved in such a task has already been expressed. If imagery is used there is little certainty about its modality. Early experience of a bicycle for instance is not only visual but must also be tactile and locomotor. By what means past experience of this object is retained and currently conjured up, is difficult enough to introspect upon, let alone infer from the drawn responses of aged people.

Where response is wholly correct in the tests requiring reproduction from immediate memory, it can be said that the subject in addition to perceiving correctly, retains momentarily, and recalls the configuration of designs in two or three-dimensional space.

Where portrayal of gestalt is correct but execution is wrong, perception of design must be correct but planning of motor activity or motor activity itself may be at fault. In other words the

arrangements of lines, component parts, or the whole design in relation to the page may be at fault, though the general configuration of the design may have been well displayed. Faulty motor activity itself, refers to defects within the lines of drawing; fragmentation, tremulousness and overscoring which appear in designs which are nevertheless well displayed.

While this may be true under conditions of direct copying and spontaneous construction it is not necessarily the case in reproduction from immediate memory, where the circumstances in which perception occurs are different. Here, motor activity can begin only after scrutiny of the object or design is complete. If execution only is at fault in reproduction from immediate memory, it may be for the reason given above or for another reason; namely, that while planning for motor activity might have been faultless while the model was under direct vision, execution fails because planning is not retained when the model is no longer present. This would imply a selective failure in retention; a visual image persists but the analysis of this image for the purpose of reproduction fails to be retained long enough to guide motor activity and so give definition to the configuration.

Where portrayal of the gestalt fails but execution is good, perception, in the sense of cognition of the design, may be at fault. Other factors might determine this kind of response however, and these should now be considered.

Firstly when the subject is require to construct a series of designs, the gestalt of the forms in the items constructed after the first, may fail to correspond to the model by reason of perseveration. When this occurs it cannot be said that there

is a primary failure of cognition, so much as a disturbance of attention, whereby perhaps the image of a design perceived early in the series persists, or fails to be extinguished by the act of perceiving a subsequent design. Execution in these circumstances may be faultless while portrayal of the appropriate gestalt fails.

Portrayal of gestalt may also fail because of a total or partial failure to comprehend the given instructions. "No effort to respond" could be the outcome of total failure of comprehension. A partial failure of comprehension of instructions might explain a response where a design is constructed which does not correspond with that of the model. In a correct response the subject must not only grasp the notion that he must construct, but also that he must construct a particular design which is named, or a model of which lies in front of him. In a response where gestalt is incorrectly portrayed the subject may not have grasped the particular notion of constructing a special design while grapsing the more general one of engaging at random in motor activity with the material at hand.

Thirdly, under certain conditions (spontaneous construction) failure to portray gestalt may be the outcome of failure to recall material first learned long ago and subsequently repeatedly experienced. In other conditions (reproduction from immediate memory) failure to retain or recall recently perceived designs may determine failure to portray gestalt.

Fourthly, failure of gestalt could occur in spontaneous construction as a consequence of the subject's failure to construe the verbal symbol contained in the instructions in terms of the reality which he is required to construct; e.g. when he writes

"square" or "draw a square" instead of drawing a square as he should do.

Some of the determinants of failure just described can be identified as present, or excluded, by means of examination of individual items, or series of items of response. One can say with confidence that perseveration occurs by glancing at a series of test items; and by examination of the first item of the same series, whether or not the subject is capable of portraying gestalt accurately.

By examining the character of responses in a series of items one can infer with some degree of confidence that failure to comprehend instructions is not the cause of failure to portray gestalt. If, for example, the subject has correctly constructed the required design of the first 3 items of a 6-item series but failed in the last 3 items, it can be reasonably assumed that he has grasped the nature of the general principle of the task required of him, but failed in the items concerned for some other reason. If he fails to respond to any item or grossly fails to portray gestalt in any of them, then the opposite inference cannot necessarily be made. It may be a total failure in comprehension, but it may on the other hand signify a total failure of cognition in all items.

If the subjects are presented with the same series of designs twice under different conditions and perform consistently worse under one of these conditions than the other, it is likely that the difference in conditions determines the discrepancy of response. If response is invariably worse under conditions of spontaneous construction or reproduction from immediate memory than under conditions of copying, then some defect in an aspect of memory function must explain the discrepancy between the two series.

Failure to construe symbols in the required terms is identifiable on examination of individual items.

These matters of certainty and doubt about the general interpretation of results in this kind of material have been discussed as a preamble to the more particular consideration of the meaning of the findings under review.

It is clear that some items in the tests comprising this series of tests, pose the subject with tasks which are more difficult. Some tests as a whole are notably more difficult than others. Some of the conditions under which testing must take place present difficulty which other conditions do not. Some subjects within the patient group experience more difficulty in performing the tests than others in the same group, and finally it is clear that the patient series as a whole perform every test worse than the control series. The nature of these discrepancies will now be discussed under the headings I - III. Varying conditions and differences in patient subjects are referred to throughout where they are relevant.

1. DISCUSSION OF ITEM DIFFERENCES.

The first test in the series of tests - spontaneous drawing of simple geometrical designs - is simple by the standards defined on p. 18 (Introduction). It contains items which, as gestalten, are irreducible. These are well known geometrical designs. The group of designs contains, within it, a variety of qualities which might be worth listing before consideration of which of these qualities affects performance. The square and cross contain straight lines which join one another at right angles only and are parallel to the borders of the page upon which the designs are drawn. Triangle and diamond have straight lines which join

at angles which are not right angles and which are not parallel to the borders of the page. The circle is the only figure containing a curved line. The cross is an open figure; all the others are "closed". The designs differ in respect of the number of shifts of orientation which the drawer has to make to complete the drawing of the gestalt. The circle can be said to require no such shift. Once the notion of the need for a curved line is grasped one sweep of pencil on paper should be enough to complete the closed figure. The cross needs only one shift of orientation, the triangle needs two and square and diamond three.

These five figures therefore present the prospective drawer with problems which are not the same. It might be assumed that one shift of orientation presents less difficulty than three shifts. The work of Shapiro [27] (1954) suggests that designs with diamond orientated angles (triangles and diamond) present more difficulty than those, like square and cross, whose orientation is right angular and parallel to the page borders. Whether the construction of a curved line poses greater difficulty than that of a straight line is not easy to say. The same doubt applies to open and closed figures.

If one now rates the problems posed by each figure one might hypothesise that the circle would be easiest to draw. No regard need be paid to the dimension of angles or the orientation of page - line parallelism. No shift in orientation is necessary. The cross would be next in order of difficulty. It requires a shift in orientation while drawing, though only one. It also requires attention to the relationship of the figure to the page borders, though the correct choice of this relationship for this figure must be regarded as the easiest possible; namely a parallel one. The square should be next in order. Shifts in orientation

while drawing are three in number. The relationship of the design to the page has the same quality as the cross. The triangle and diamond should by this hypothesis present the greatest difficulty. Both require shifts in orientation, and both require attention to the relationship of the figure to the page borders; the correct choice of which is a more difficult one than that which occurs in square and cross.

The results in Test 2 (copying simple geomatrical design) performed by patients tend to support this hypothesis. Of all the designs the circle is most frequently satisfactorily drawn, while correct drawing of triangle and diamond is low by comparison. The frequency of correct drawing of square and cross lies between the corresponding frequencies for circle on the one hand and triangle and diamond on the other. This state of affairs occurs when a guiding model is present from which to copy. When the same problems must be dealt with in spontaneous drawing the tendency referred to becomes even more marked.

In copying there is a difference in the quality of response between square, circle and cross on the one hand, and triangle and diamond on the other. 9 patients who succeed in the former, fail to achieve gestalt in the latter designs, and this is the only major change between the two groups of designs. Considered as a pair, triangle and diamond's only distinguishing feature from the square and cross is the lack of parallel alignment of their component lines to the borders of the page. It is this feature therefore which must make for the greatest difficulty in reproducing the gestalt, though not in exercising executive ability, which latter is no worse in triangle and diamond than in the other designs. If one examines more closely the efforts of these 9 patients who fail to portray the correct gestalt in drawing

triangle and diamond, a tendency to incorporate diamond-orientated elements in a square orientated framework suggests itself. JJ is perhaps the extreme. He draws a firm overscored vertical line only after considerable (gestalt) success in copying the other three figures. Cu when copying a diamond draws a single vertical line then attaches two other lines not parallel to the page borders. M'L in both designs seems to draw two sides of a square and two sides of a diamond-orientated figure. JM makes three sides of a square with a diamond-orientated V insertion. ET draws a roughly square-orientated figure instead of a triangle. All these patients achieve gestalt in their other drawings. They seem to fail, not because they have failed to perceive the quality of diamond-orientation of the model (for this quality is recognisable, in part, in many of their reproductions) but because, when drawing, some other cue influences their choice of orientation of design. Two influences are at work perhaps in the production of these faulty designs. (1) The influence of the instruction and the stimulus (model) which if correctly perceived, tend to force the drawn design towards diamond-orientation. (2) The influence of the page-borders on the design, which would tend to force the drawing towards square orientation. The edges of the paper are the closest and most conspicuous cues the patient has. They are straight, join at right angles, and whole form is placed in square-orientation before the drawer. He might draw his line along the edge of the paper, i.e. running his pencil over the "design" already there. This would make no impression however, and drawing within the margins of paper is anyway a previously, frequently practised convention. If still guided by the paper "design" he must draw his line within, but parallel to the margin of the paper and so start off a square orientated drawing. If this

speculation were to be tested, then patients' drawings of a square on square orientated paper would have to be compared with their drawings of a square on paper, whose outline had another shape.

A third and more speculative standard of reference, freely available to the subject facing the task of orientating a design on paper, is the generally vertical nature of the longitudinal axis of the subject himself. The healthy individual is able to perceive the verticality or otherwise of objects in his environment in the absence of all other cues except the persisting verticality of his own body - the Aubert phenomenon (Brengelmann (1957)). When that verticality is disturbed and all other cues are withdrawn also, then the ability to identify the verticality or otherwise of an illuminated line against a black field, is lost. One could infer from these phenomena that in the absence of other cues, one's body verticality allows one to perceive (and perhaps draw) square orientation, and orientation that is not square. If one loses the sense of body verticality one would have to depend on other environmental cues (e.g. square-orientated quarto drawing paper). This might allow the reproduction of square orientated designs but not of others. In the same circumstances, namely where there is a disturbance of the notion of body verticality, diamond-orientated drawing paper would provide cues for the drawing of diamond-orientated but not other orientations. This hypothesis might be tested in patients with vestibular disorders by comparing their efforts at drawing diamond-orientated designs on square orientated paper with drawing the same kind of designs on diamond-orientated paper.

The latter part of this discussion has been speculative. Some ways of reducing speculation have been suggested.

The evidence which emerges so far is that diamond-orientated designs present difficulty which square-orientated designs do not, and that features of the faulty responses suggest that the cues which are normally present to allow the construction of diamond-orientated designs are missing, while cues (square-orientated paper) which favour the construction of square-orientated design, are fortuitously present.

TEST 5 (ABELSONS) has items consisting of intersecting designs of the kind just discussed. Only three are used; namely circle, diamond, and triangle. Every item contains either a diamond or triangle. All but the first two items contain both these shapes. In view of the foregoing discussion this test should therefore present difficulty. The items vary within this test in having different numbers of component geometrical shapes. The more geometrical shapes a design contains the more often is it wrongly identified and copied by patients. The group of normal aged subjects make perfect identification. It must be recalled however that the quality of identification required for naming does not correspond to that required for copying. Where naming only is required the task is one of perceiving a hidden figure. The individual must pick out from a mass of lines a single familiar geometrical shape. In some items this is relatively simple; in others not. It is clear that individuals in the group of normal aged have been able to perceive in Item 5 (the most complex) a single closed shape even when its outline is interrupted and intersected by other lines.

The way the normal subjects have perceived these complex designs is in fact the most economical. The whole of Item 5, for example, is usually described in 4 words - (two circles, triangle, diamand). Only well-known, closed figures are perceived though

many shapes are in fact present; some of them nameable, e.g. ellipse, crescent. This occurs despite the instructions which do not instruct the drawer to perceive any particular kind of shape.

Only 14 of 40 patients succeed in identifying all 4 shapes in Item 5 of Abelson's test. Not one patient copies the item correctly.

There is a small group of 6 patients who not only fail to make a correct identification of Item 5 ("G" response) but who misidentify aspects of the complex design. Thus AF describes it as a cross, square and circle, Ha as a circle, peak, semi-circle and cross, He as two circles and a 'V', M'D as two triangles and two circles, M'G as two circles, triangle and a stroke, and JM as triangle, circle and part of a circle. (All other patients making a "G" response identify the shapes correctly up to a point but not completely). If one examines the copied drawings of those 6 who misidentify, it is clear that most of their drawings contain a representation of the misidentification. AF and Ha both draw crosses. He draws a 'V', M'G shows strokes, and JM shows only what is identified, viz. a triangle, a circle and part of a circle. Thus 5 out of these 6 patients misidentify, in naming, the same feature of the drawn design which is faulty.

Of the 13 patients whose naming is at fault because it is incomplete, 8 draw designs which are incomplete in respect of one or more geometrical shapes. None draws all 4 shapes.

Of the 13 patients who name the shapes in the item correctly, 7 draw designs which contain all 4 component shapes. This is the best type of drawn response in Item 5 and it occurs only among those who identify correctly.

One can conclude from the results just mentioned, that, in the case of complex designs of this kind, the quality of drawn reproduction depends on the ability to isolate perceptually, with the greatest economy, components from the total design. These results also make it clear that failure to perceive the nature of the whole design, in terms of its component shapes, accounts for distortions of gestalt when it comes to drawing. The primary failure in thise case is one of perception.

If one examines closely the results of those 13 patients already discussed who name 1 or 2, but not all, of the component shapes of Item 5, it can be seen that all 13 name circles, only 4 name triangles and only 6 name squares (diamonds). 9 patients of those 13 have drawn responses. All 9 include a circle in their drawing. Only 3 include a triangle and only 1, a diamond. So one might conclude that, not only does perception break down when faced with complex designs of this kind but it breaks down in respect of shapes orientated in a certain way.

The discussion at the moment has in effect been dealing with two of the three groups referred to in the results, viz. "Non-G", where naming and drawing are on the whole good, and "G" where both are bad. It was clear, even among those patients who made up the "Non-G" group that the more complex designs were those in which the small number of errors of gestalt occurred. Even more strikingly it was seen that in the intermediate "+G" group, errors of gestalt were made by only $\frac{1}{3}$ of the patients drawing the simple items (1 and 2) but in nearly all the patients drawing the most complex items (5).

All the designs in the Abelson's series presented here, however, contain at least one diamond-orientated shape. The copying of these seems to meet with more success in circumstances where the shapes

are relatively "uncluttered" (i.e. in the first items) than where the design is complex. It might seem therefore that where complexity is beyond perceptual capacity, those aspects of the complex form which are diamond-orientated are those which fail to be perceived (and reproduced) thereby disturbing the perception (and reproduction) of the whole form.

These results suggest that perception in the restricted sense in which this study understands it, is breaking down under the weight of increased complexity. The designs here are complex not because their component parts are unfamiliar but because recognition of any individual component shape is hindered by the presence of other shapes partially overlying it. The influence of faulty perception can therefore be seen on construction.

However faulty, perception does not account for all the defects in the drawn design.

When the results of copying Abelson's figures are considered as a whole, distortions of gestalt are more common in complex designs than in simple ones. Errors of execution, however, remain constant; they are as common in Item 1 as in Item 5. They are as common in square-orientated as in diamond-orientated figures in simple geometrical designs. They are rare in the circle. The circle differs from the other shapes described in requiring no change in the direction taken up by the drawing pencil after drawing has begun. In other simple geometrical designs and even more so in Abelson's designs, the number of shifts of direction required after the first is always more than in the case of drawing a solitary circle. In Item 5 of Abelson's for example, 8 shifts of direction would be necessary to complete the design. This difference between the circle and the other designs might perhaps explain the relative excellence with which the former is copied.

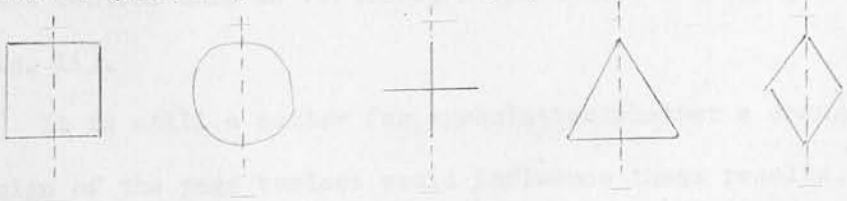
In Test 6 (Copying Bender-Gestalt) Designs 1 - 3 present the greatest difficulty. They are least often correctly copied. They show more gestalt distortion than the other designs. The characteristic which distinguishes these three designs from other designs in the series is their construction with dots or loops. These units of construction go to make up secondary components, viz lines of dots, and the lines may be further arranged as a parallelogram in Design 2, or 3-sided figure in Design 3. The units of construction in all other designs in the Bender-Gestalt series is the line itself. Designs 1 - 3 contain basic units which are smaller than that.

To have to construct with dots or loops what is usually the basic unit of construction (the line) is a laborious, time-consuming, unfamiliar task which forces numerous shifts of direction of the kind described above, and seems to militate against the achievement of gestalt. These designs (1 - 3) demand from the drawer a degree of repetition which the line drawings do not. This quality of repetitiveness seems to have the effect upon the drawer of seducing him away from attention to the larger aspects of the figure's design. Many deal efficiently with the drawing of dots or loops. Most contrive to arrange these dots in a linear series, but the next order of arrangement, viz. arranging a number of linear series of dots in such a way that two-dimensional form is produced, is beyond most members of the patient group. The first and last designs in the series (A and 8) are drawn best by most. Item A consists of an arrangement of two familiar geometrical shapes whereas all the other designs are rather novel, either in minute structure or whole design. The last item (8) is the only one of the line drawings which is symmetrical about a central vertical axis. This quality will be discussed again.

Items 4 and 7 in the Bender Gestalt series have elements which should be orientated parallel, and elements which should be orientated in a way not parallel to the page borders. The vertical hexagon in Item 7 is indeed vertical in 27 of the 32 attempts. The diagonal hexagon's orientation is correct in only 18 of the attempts. All those who attempt Item 4, draw 2 or 3 sides of a square in good square-orientation. 13 patients however rotate the spur-shaped appendage in this item so that its central axis is either vertical (parallel to the sides of the page) or more rarely horizontal (parallel to the top and bottom of the page).

Rotation of those parts of designs whose central axis is not in a line, parallel to the sides of the page, is seen here. This defect is not quite the same as that seen in the frequent failure in drawing diamond and triangle in simple geometrical shapes. In that case the greatest distortion in gestalt took place in a figure (diamond for instance) whose central axis was parallel to the page border, i.e. those

parts of the design on each side of the vertical central axis are mirror images of one another. This was true of all the designs in Test 1 (simple geometrical designs).



In those parts of the Bender-Gestalt series presently under discussion the central vertical axis of the part as it stands does not leave on each side of it two parts of the design which

are mirror images of one another.

Item 4

Item 7

The other parts of these designs have portions on each side which are symmetrical about a vertical axis.

Item 4

Item 7

It appears therefore that it is not only more difficult for patients to reproduce designs with sides not parallel to the borders of the page than designs with sides parallel (e.g. diamond more difficult than square), but it is also more difficult for patients to copy designs which are asymmetrical about a central vertical axis, than those which are symmetrical about such an axis, e.g.

i

is more difficult than

ii

This might be expressed another way; that patients have more difficulty in copying designs whose central axis is not vertical or not parallel to the borders of the page (Fig. i) than in copying designs whose central axis is vertical, or parallel to the page borders (Fig. ii).

It is still a matter for speculation whether a change in the design of the page borders would influence these results. If it did, it might suggest that the design of the page is exerting in the senile patient an uninhibited and distorting effect upon the process of orientating designs in space, and that some control, other than visual, is usually also in operation (e.g. the awareness

of body verticality), to guide the orientation of design whose edges or axis are not parallel to the page border.

There is perhaps a tendency to under-emphasise the role which forms of perception, other than visual, have in learning. It would seem quite reasonable for instance to postulate that our learning of the nature of what is, or is not, perpendicular to the horizon, was in the first place information derived from comparisons with the usually vertical posture of our own body. Ultimately, visual recognition would merely remind us of these comparisons, and consciously take their place.

In Test 8 (Draw house, a man, tree, bicycle)it is difficult to contrast the items. They are very different. The standard of scoring differs. Room for error is small in drawing a tree but large in drawing a bicycle. A few imprecise lines will convey satisfactorily the idea of a tree. A bicycle demands many precisely related lines to convey its identity. The results show that the tree gestalt is portrayed by 16 patients while the bicycle gestalt is shown by only 5. House and man are drawn recognisably by as many as is tree. In all the objects except the bicycle a normal response can occur within wide limits. The nature of these three objects is such that responses as divergent as drawings of Buckingham Palace or a wooden shack would convey the notion of house and be scored correct in respect of "G". In the case of a bicycle the limits within which a normal response could occur are much narrower.

In the tests considered so far it has been possible to describe the quantitative (Item 1 and 5 of Abelson's) or the qualitative differences (Items 1 and 5 of simple geometrical figures) between items. These differences are difficult to discriminate in drawings

of house, man, etc. The only contrast which will be attempted refers to the exceptional status of the bicycle. While it would be possible to portray a bicycle in a way that made it symmetrical about a central vertical axis "front on", all the patients who have attempted it, have drawn it "side on". It is thus an asymmetrical design. The majority of patients have on the other hand chosen to draw the other figures as symmetrical ones about a central vertical axis. In this respect therefore the bicycle may suffer. If this quality of symmetry makes for ease of drawing, and a choice is offered it should be strange that the symmetrical form is not chosen. All those in the control group choose the "side on" view. It will have to be assumed that for a bicycle this is the convention for dealing with a drawing which is not formally symmetrical but which is balanced in a near-symmetrical way by two wheels.

In plain block designs the last design (Item 8) is least often, and Items 1 and 2 are most often, constructed correctly. The factors which distinguish these items have been described in the section on results. Item 1 has a small number of blocks; it is, by definition, one-dimensional and it is symmetrical about a central vertical axis. By contrast Item 8 has twice the number of bricks; is three-dimensional, and is asymmetrical about a central vertical axis.

In direct copying, if one considers only the number of bricks involved in the items, roughly speaking those containing most bricks are copied wrongly in respect of numbers, and those items containing least bricks are most often correctly copied in respect of numbers. This correspondence is even more exact in reproduction from immediate memory, where Item 8 is least often correctly

performed in respect of numbers.

There is the same rough inverse proportional relationship between number of dimensions and number of patients making correct response in respect of dimension in copying. This inverse correspondence is again more exact in the case of reproduction from immediate memory.

Symmetrical items tend to go with a high score in respect of symmetry. Asymmetrical items tend to go with a low score in respect of their asymmetry. The correspondence is again more exact in reproduction from immediate memory than in direct copying.

Where complexity increases in these three factors, efficient performance of them is correspondingly reduced, in circumstances where the factors must be retained momentarily before construction begins. Where no retention is required, i.e. where direct copying occurs, increase in complexity in any individual factor does not have the same effect upon its efficient function. In circumstances of direct copying function is only affected by coarse changes in complexity. In copying Items 8 and 3 where all three factors are at their most complex, copying is most often wrong. Item 1, where all those factors are at their least complex, is copied wrongly least often. The items between, which vary slightly inccomplexity do not vary in the number of correct responses.

It is difficult to say which one, or what combination of these factors influences performance in seniles. It may be that it is not the nature of the factors which poses difficulty, so much as the number of complex factors which the patient has to wrestle with at one time. The results in this test (plain block design) do not clear this doubt away.

In the test Sticks in plasticine, there are identifiable differences between the items. Item 1 requires only two sticks (inevitably in the same plane). Items 2 and 3 have three sticks all in the same plane. The other 7 items have 3 sticks in more than one plane. Differences between these 7 are not great. One (Item 9) is different from the other multi-planed items in that it is symmetrical about a central vertical plane which could be regarded as a projection of the median sagittal plane of the patient's body as he sits facing the model. A similar projection of the body's median sagittal plane could not divide any other item in this series symmetrically. Item 9 is performed correctly more often than any other, except the single-planed items. It is now proposed that it is its uniquely symmetrical quality which determines Item 9's scoring position.

The two halves of such a design are mirror images of one another, as are the halves of the body on each side of its median sagittal plane.

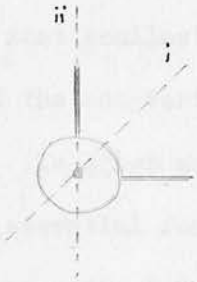
In this test there is no page to guide orientation. The generally vertical orientation of the long axis of the body is however available. It happens to have much in common, in the way of principle of construction, with Item 9, but no other item of the test. Asymmetrical design appears to present greater difficulty to seniles. Indeed there is some influence at work which seems to reduce the latter designs, whose construction is attempted by seniles, to symmetrical forms. One of the common faulty responses in this test has already been described as "reduction to symmetry".

Seniles' success with Item 9 of this test thus emerges as less of an achievement, when we see it in this light. The reduction of design to symmetry (about a median sagittal plane) which

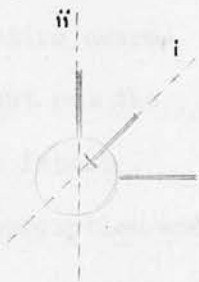
is a feature of seniles' attempted constructions of asymmetrical designs, suggests that performance is over-influences by perhaps the only available external standard, i.e. body verticality.

In the senile patient perception (and construction?) of designs with a vertical axis is relatively efficient. In the case of Item 9 of sticks in plasticine, the identifiable axis is also a vertical one. This is not true of the other 7 multi-planed designs.

item 9



item 4



item 5

In Items 4 and 5 there is a plane (i) on each side of which exists fragments which are mirror images of one another but the plane is not vertical. The fragments on each side of the median sagittal vertical plane (ii) are not symmetrical.

In Items 6, 7, 8 and 10 the design presents no plane on each side of which would be fragments that are mirror images.

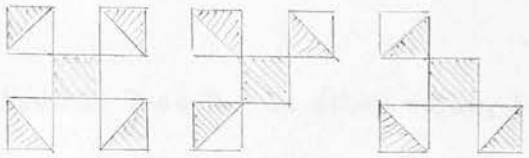
It may be noted that in Items 4 and 5, which can be described as symmetrical about a certain plain (i), there occurs the smallest number of "reduction to symmetry" errors. In these items the percentage of attempted responses which are symmetrical about the vertical plane described is 19 - 20%. In Items 6, 7, 8 and 10 the percentages are 28 - 68%. Next to Item 9, Items 4 and 5 are the best performed of the multi-planed items. These results suggest two factors making for ease of response. (1) The existence in the model of any plane separating symmetrical fragments of the design. (2) The existence in the model of a particular

median sagittal (vertical) plane separating symmetrical fragments of the design.

It seems then, that if the design has a central axis, a backbone as it were, it is more easily constructed. If that backbone is also vertical then construction is even more easy. If we continue to postulate a relationship between the existence or awareness of body verticality, and the ability to perceive and construct the vertical and non-vertical aspects of design, then it would now have to be proposed that seniles' defective awareness of body verticality impaired the non-vertical but not the vertical aspect of construction. In other words an intact awareness of body verticality is essential for the perception and construction of the non-vertical aspects of design.

The difficulty posed by the three-dimensional items (4 - 10) compared with the single plane items (1 -3) is shown up in the latter groups' frequency of correct scores. Only Item 9 in the three-dimensional group has a number of correct responses greater than the number in any of the first three items.

The items in Kohs' Blocks are not equally well performed. Item 5 in this series is constructed correctly by only one of the 40 patients. It is so grossly different from the other designs in requiring 9 bricks, that its almost invariably faulty construction must be attributed to this difference. The results show that only 5 patients attempted this item, and only one of these succeeded. All 5 had constructed Items 1 - 4 correctly. 3 of the 4 faulty attempts show responses which shows some correct awareness of the general aspect of the design.



Thus patients neglect the white blocks in the design, and though they perceive the primary design to a large extent, they are unable to orientate the four corner blocks correctly. It must be noted that these blocks contain lines which are diagonal to the main dimensions of the whole design.

The Items 1 - 4, which contain 4 blocks each, are comparable. Item 1 clearly poses less difficulty than Items 2 - 4. The former differs from the latter group in needing no half (diagonal) blocks for the construction of the design.

II. DISCUSSION OF TEST DIFFERENCES.

It is appropriate to consider under this heading the broad division, made in this study, between the two types of error - gestalt and executive. The validity of making such a division and its significance may be judged by matching test differences, in respect of these errors, against the known differences between the tests described on p. 18-19. (Introduction).

Test 1 differs from Test 2. (Copying and spontaneous drawing of simple geometrical designs). It is perhaps hardly surprising that gestalt is conveyed correctly less frequently in Test 1 where no model is present. It is somewhat unexpected that in the same circumstances (Test 1) execution is better than where a model is

present, i.e. in Test 2. In other words, in copying errors of gestalt are less frequent and errors of execution more frequent than in spontaneous drawing. These executive errors occur in copying in a group of patients who made no such errors in spontaneous drawing of the same design.

Spontaneous drawing facilitates execution or copying hinders it. Both statements may be true. Spontaneous drawing of a geometrical design does not demand the meticulous assessment of the dimensions of a particular design, whereas copying does. In copying the need for specificity is greater. So in this respect it is not quite correct to say that the two tests differ only in respect of the presence or absence of a model. The presence of a model determines the need for specificity. The absence of a model allows the testee to be less specific. The specificity referred to here relates to the dimensions of a particular design not to the nature of the design (gestalt) itself. It is dimensions (size of angles, length of lines, etc.) which one would expect to find more severely at fault where the need for specificity is greater.

Copying could be regarded as more complex than spontaneous drawing in that it demands not only the drawing of a shape (the common requirement in both tasks) but the drawing of a shape to particular specifications.

Spontaneous drawing on the other hand is more complex than copying in requiring the ability to interpret verbal symbols and recall material learned long ago.

The nature of the errors in the responses to these tests suggests that the identification of the class to which a design belongs and the analysis of the dimensions of the particular

design within that class, are perceptual tasks of a different order, which are differentially affected in senile dementia.

Copying designs by drawing differs from matchstick construction of geometrical designs. The conspicuous difference between the two tests, namely, that in copying matchsticks designs, the units are prefabricated, means that a large body of executive errors cannot be made in performing that test. Executive errors are fewer in copying the matchstick than the drawn geometrical designs. When spontaneous and copying construction are compared in matchsticks, both executive and gestalt errors are less common in copying. The findings in drawing are different. There, executive errors are more common in copying. This supports the notion that whole results in matchsticks are superior because prefabricated parts are supplied to the constructor, thereby limiting the number of executive errors it is possible to make.

Copying single geometrical figures differs from copying them in the arrangements required in Abelson's figures. The new feature in the latter test is that the familiar simple geometrical shapes are no longer discrete but tend to be hidden by the intersection of other simple geometrical shapes, thereby complicating the task of identifying any one of them. Specificity is even more intense here. Not only must each component shape have special dimensions of its own (as in Test 2) but it must also relate to the other component shapes in conformity with particular specifications. The complexity of specificity is therefore great, and extends beyond that required in Test 2.

Copying Abelson's figures is poorly performed compared with copying simple geometrical shapes. There is evidence that identification, as far as it is required to go, is well performed by the patients. It seems unlikely therefore that its failure alone

would account adequately for the poor standard of drawing. The failure to analyse the precise dimensions of a recognised design must strongly contribute to the poor response.

Examination of the results in Abelson's figures (Table VII) shows that those who recognise the designs make more combined errors of gestalt with errors of execution "GE" and fewer pure errors of gestalt "G" (i.e. without identifiable executive errors). Those who fail to recognise the designs make more pure errors of gestalt.

The preponderance of pure errors of gestalt in the latter group suggests that gestalt fails in construction because it has failed to be recognised perceptually.

Where recognition is better (in the former group) gestalt also breaks down, but in commoner association with executive errors. Though gestalt is recognised (perceived) and named verbally, it fails to be conveyed even broadly in drawing. The disturbance of execution in this group may be so severe that gestalt becomes unrecognisable.

Whether this is the mechanism or not, it is clear that the failure to portray gestalt in certain members of this group has more than one cause.

The Bender-Gestalt test differs from the others in having not only complex designs but also unfamiliar ones. The different quality of the items within the test has already been discussed. The whole test differs from others in this respect. The quality of items within most of the other tests used is much more homogeneous; and where difference in items occurs it tends to be a quantitive one. In Bender-Gestalt there are clearly qualitative differences between groups of items within the test.

Comparing the copying task with reproduction from memory in Bender-Gestalt, executive errors are much more frequent in the former, and errors of gestalt more frequent in the latter. This seems to correspond to the difference which emerges when comparing spontaneous and copying performance in drawing simple geometrical designs. One might therefore draw the same inference from it.

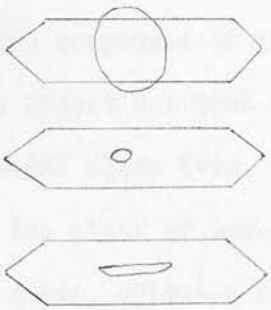
The similarity of these comparisons also suggests that the problems, which spontaneous construction and reproduction from immediate memory present, are similar. They both contrast with copying in the same way. Spontaneous construction requires the recall of material learned long ago and probably frequently reinforced since first learning. One must assume that the essential nature of designs like square and cross have been learned in the past and retained and that the current difficulty is in recall. In failure of reproduction from immediate memory there is less certainty wherein the memory defect lies. Consideration of patients' reproduction from immediate memory of Item 8 in the Bender-Gestalt may help to resolve this doubt. Those patients who make an effort to respond nearly always begin with the part of the design shown below

i

On the whole they draw this well and quickly. Their next move is less certain and only 5 out of the 40 patients achieve the enclosed diamond accurately.

ii

It must be remembered that when the patient is drawing the first part (i) of Item 8 he is doing so immediately after scrutinising the whole design. Accurate reproduction of part (i) of the design means that it has been learned and retained. The fact that that part of the design drawn last is more frequently drawn incorrectly suggests that the retention of the design is fading while response is going on. Many of those who recall the first part (i), but fail with the diamond (ii), do recall that some other shape is involved, e.g.



This sequence of defect shows up even more clearly in the performance of the control group, where the gestalt of part (ii) of the design fails in 8 of the 20 patients; there is no failure in part (i).

It is clear that the task of copying the Bender-Gestalt series is more difficult than copying the five simple geometrical designs. Diagram D (page 107 Results) analyses the character of this increased difficulty. Patients who correctly draw the simple designs make executive errors in the Bender-Gestalt. Those who make executive errors in the simple designs make executive errors in Bender-Gestalt, and these executive errors are mostly in designs where gestalt has failed to be copied correctly. The number of pure gestalt errors is small by comparison. This suggests that in a complex task like copying the Bender-Gestalt designs as in

copying Abelson's designs, gestalt fails to be portrayed as a consequence of executive failure.

Drawing house, man, tree and bicycle differs in perhaps being more difficult to assess as a single test than any other. The results however show that a group of patients has contrived to portray certain elements of gestalt without conveying the precise nature of the object asked for. For example a house is often portrayed as a square with small rectangle (chimney) on top or as only three sides of a square. There is a tendency for such elements to appear in the responses of these patients' efforts at other drawings. The object has been constructed up to a point which signifies its general class (viz. in the case of a house - an object belonging to the class of box-shaped things) but no further. The windows, doors, chimneys and roof which would turn the box into a house are missing. The ability to draw a house on verbal instruction must depend on what is retained of early experience of houses and perhaps of drawing them. It is possible in seniles that this experience is no longer available in "good focus". It is clearly available in some way because no patient for instance, asked to draw a house, draws two circles, and no patient, no matter how gross his failure in drawing a bicycle, draws a square box. One might almost say that senile patients communicate the constructional principle here but fail to define the primary detail. One might put this another way. The construction of an appropriate general gestalt has occurred, but the patient fails to give it the specificity which even a door and a window would endow it with. The task here requires something quite specific in response which is being given instead undifferentiated from a general class of objects. It is perhaps surprising that the drawing of isolated

detail (windows, doors, etc.) is not more common among the faulty drawings of these patients. This kind of detail seems to pose a greater problem than the box-like principle of a house. It is likely that the framework of the box is necessary to make the placing of the detail meaningful, but its existence creates the need for the placing of parts according to a plan to define an object within a class, and it is this planning which appears to pose seniles with great difficulty.

The Mannikin is in effect a single-item test. The requirements of the task in this test have something in common with Abelson's, namely that they incorporate an act of verbal identification of the pieces. The similarity ends there however, for the identification of the mannikin requires the subject to perceive the nature of the completed object when the parts are scattered in front of him. Results show that the ability to carry out this kind of perception facilitates the best construction of the mannikin. None of those who failed to name the object beforehand, succeeded in constructing it. All but 4 of those 21 made errors of gestalt, or for one reason or another did not even begin the constructional part of the task. All but 5 of the 19 who identified the nature of the scattered parts succeeded in portraying the general idea of the gestalt.

These results emphasise the role which perception in the narrow sense plays in the whole process of construction. In the task as it is set here the tester has, as it were, interrupted the process of construction to enquire from the subject about how successfully he has performed its first stage of recognition. This is not simple recognition, for the patient is not naming the object in front of him. He is naming an object which would

exist if the pieces in front of him were put together in a special way. This might suggest that the planning of construction occurs even as a prerequisite to the act of naming. That individual parts (especially the face) give strong clues to the nature of the whole, makes the last assumption unjustified, though still possible.

PLAIN BLOCK DESIGNS differ from the foregoing tests in involving another dimension. The number of wholly correct scores is however higher than in some two-dimensional tests, e.g. Abelson's and Bender-Gestalt. Whether it is justified to compare a test like this which involves the manipulation of a number of identical objects with a drawing test where the same object (the pencil) is manipulated in a number of different ways is not certain. The crudest measures (raw scores) suggest that it is easier than the drawing task. The failures in the two tasks are not comparable however for the good reason that different skills are involved in construction. Drawing makes demands of the patient at a level of construction which involved the most primitive part of the design - the construction of the units of construction themselves (e.g. lines); whereas in block design the units of design (blocks) are given prefabricated. One cannot enumerate the units of construction in drawing, for they are not usually identical. Enumeration is possible in block design where the units are the same. The number of dimensions is uniform in drawing tests, but can be said to vary in block design. Only the factor of symmetry is common to the two types of test. The results here when compared with drawing tend to confirm that at the primitive level of construction of units seniles break down.

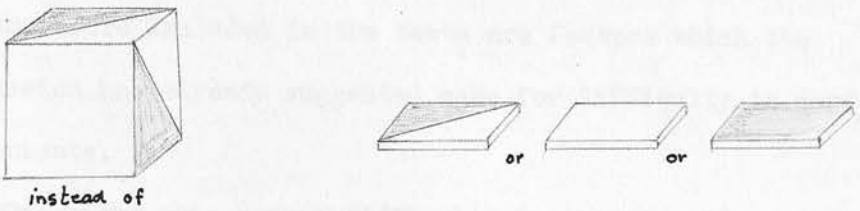
KOHS' BLOCKS has much in common with plain block design. It involves the manipulation of blocks in space. The character of this manipulation differs from the plain blocks in requiring a special surface of each block to be orientated in a special way in relation to all the other blocks. The identical quality of the plain blocks makes this peculiar type of manipulation unnecessary. In Kohs' a manipulative act through three-dimensions is necessary as a prerequisite to the construction of a two-dimensional design, which is in fact not a design of blocks so much as a design upon the surface of blocks. This design depends upon colour contrast for its character. Though the design is copied the model is not, as in plain blocks, an exact copy of the required construction, but a smaller scale diagram.

In terms of complexity, Kohs' is therefore exceptional. The individual must simultaneously consider three-dimensional manipulation, number of blocks, colour contrast, block design, unfamiliar surface design, and the process of conversion from a plan to a three-dimensional form. The relevance of complexity considered in this way has already been discussed on p.221 (Discussion) where items in plain block designs were considered. It was there suggested that the number of variables as well as the character of specific variables may be determinants of the quality of response. The different character of individual items has been discussed. The very poor performance of patients in Kohs' compared with plain blocks is perhaps a function of the number of variables which the patient has to scan simultaneously.

9 of the 30 patients who attempt the first design in Kohs' fail to arrange the four bricks correctly, even irrespective of the surface design (Au, FC, AF, JJ, M'L, JM, WP, AS, TW) but 6 of these (AF, M'L, JM, WP, AS, TW) succeed in constructing a very similar design of

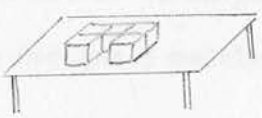
4 bricks (Item 4) in plain block design. (Test 10). This result supports the view that the number of variables itself is a factor influencing response. Attention to a large number of variables appears to determine failure in some of them, success in which can be achieved in circumstances where the number of variables is smaller.

Kohs' blocks is a test which is highly complex. A number of factors are identifiable which contribute to this state of affairs. One could reduce their difficulty and still preserve the essential purpose of the task by removing from the patient the need to make a choice by making the bricks flatter, and having only one side containing fragments of the design.

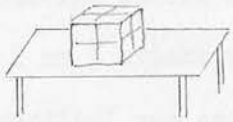


The task would then become a wholly two-dimensional one, and the extraneous complication of having to manipulate the blocks through three-dimensions would be excluded. It might be supposed that this would bring the test as a whole more within the range of senile performance than is the case as it now stands.

PLASTICINE STICKS: This test differs from others involving three-dimensional space in being least "earthbound". In plain block designs the orientation of the designs takes reference from the horizontal surface upon which the design lies. Two of its dimensions are in fact horizontal, e.g.



The other is perpendicular to the horizon, e.g.



By contrast, the body which determines the relationship of the units in sticks of plasticine is not a horizontal surface (table top) but a sphere. The sticks rarely have a perpendicular relationship to the surface of this sphere. The sticks are of course also related to the earth's surface but the relationship is not as direct as in the case of plain blocks. The actual orientation of sticks is very frequently not either vertical or horizontal, and therefore included in the tests are factors which the discussion has already suggested make for difficulty in performance by patients.

One might thus expect difficulty in this test from two factors which do not operate in plain block designs. (1) The relative removal of the design from the sort of framework (square table, and horizontal surface) by which construction of design is guided. (2) The diagonal orientation of many of the designs. Comparison of the distributions of correct score in the two tests (plasticine sticks and plain block designs) shows that the former is more poorly performed.

Yet another factor already discussed may contribute to this poor performance. It has already been pointed out that symmetry about a "median sagittal" plane facilitates good construction in copying. Only 1 model out of 10 in plasticine has this quality whereas in plain block designs 5 models out of 8 are symmetrical in this way.

The analysis of errors in this test tends to confirm the finding from other tests, that vertically orientated parts are constructed with greater facility than diagonally orientated parts. The results in plasticine sticks show that in those patients who place the group of 2 or 3 sticks incorrectly, a mean of 71% nevertheless place the vertical one correctly, while only 21.2% place the diagonal ones correctly. 34% place the horizontally orientated sticks correctly in this group. This last figure is of interest. It leads one to speculate further upon the notion (p. 211 Discussion) that in the process of learning to perceive the orientation of objects in space, the perceiver perhaps relates these objects to the usually vertical posture of his own body. He would thereby have to make a judgment as to whether the object had the same posture (i.e. vertical) or a different one (i.e. horizontal or diagonal). Horizontally orientated objects would have the same posture as the ground to which the perceiver's body is vertical, and diagonally orientated objects would contrast with both of these standards. If it were valid to assume that the perception of similarities was an easier task than the perception and definition of contrast, then a hierarchy of facility could be defined, according to which vertical objects would be most easily perceived (and constructed), and diagonally placed objects least easily perceived (and constructed) with horizontally placed objects occupying an intermediate position between the two (with regard to facility).

111. DISCUSSION OF PATIENT-CONTROL DIFFERENCES:

The question must be raised as to whether control performance has a pattern which is essentially the same as that of the patient group, though quantitatively less severely disturbed, or whether control and patient performance are in any way fundamentally different.

This question is not easily answered by simple reference to the consistently higher scores, in all tests, in the control group compared with the patient group. In general those tests which are best performed by patients in terms of frequency of correct scores, are also best performed by controls. If those tests where direct copying is required are compared with the others the difference between the patient and control group is found to be greater in tasks where a model is not currently present from which to copy. This suggests that where memory is involved the patients are at a special disadvantage, though they are clearly at some disadvantage in all tests. The aspect of memory which contributes to this special difficulty in non-copying tasks is not immediately clear. It may perhaps become so in the following discussion of individual test comparisons.

COPYING SIMPLE GEOMETRICAL SHAPES. The distributions of correct scores are markedly different but show considerable overlap. Half the patients fall within the range of control performance. Errors are made in both groups but errors of gestalt were more prominent in the patient group, and in that group almost wholly in the case of copying triangle and diamond. It may be said therefore that there is an essential difference between patients and controls, and that is that the former cannot construct, in drawing, these two designs while controls can. The possible meaning of this finding has already been discussed.

SPONTANEOUS DRAWING OF SIMPLE GEOMETRICAL SHAPES exposes the contrast

in the ability to draw triangle and diamond, just described, more vividly. In other words diamond-orientated but not square-orientated design is ill-constructed in circumstances where a learned experience rather than a current visual experience is drawn upon.

COPYING AND SPONTANEOUS CONSTRUCTION OF MATCHSTICK DESIGNS tend to confirm the conclusions arrived at in the above tests, i.e. that the essential difference between patients and controls lies in their capacity to deal with diamond-orientated designs (in this case the triangle alone).

COPYING ABELSON'S FIGURES.

The distribution of correct scores is markedly different. In general, disorders of gestalt account for failure in patients, though with increasing complexity both groups show more gestalt distortions. The two groups differ markedly in this test in respect of errors of execution which are constantly high in patients irrespective of the complexity of the design copied. In controls, on the other hand, execution is good in the less complex designs, but deteriorates with increasing complexity. This is a curious state of affairs whereby the control subject correctly identifies the shapes to be drawn, and is known to be capable of drawing them correctly when required to do so in small combinations. When required to draw the same shapes, involved in large combinations, (e.g. Abelson's, Items 3, 4 and especially 5) errors of execution occur in the drawing of the shapes which previously were drawn correctly (e.g. RPo. who quite satisfactorily draws a diamond and triangle in Items 1 and 2 shows distortion of angles andlines and rotation in these shapes when they appear in Item 3 and 4.). The placing of any individual shape in the larger combinations like Items 3 - 5 has to be more precise, as it must correctly relate to two or three other shapes rather than just one. If the first line of such

a shape is placed too far to the left or right, and the subject recognises his error, he will squeeze or extend that shape to fit the whole design, thereby distorting angles and designs to "make a good fit". Whether this also wholly accounts for rotation is not certain. The only patient group which shares this error characteristic with the controls are those described on page 67 (Results) as "non-G". There too, executive errors tend to increase with complexity. It will be recalled that this is a group who both identify well and draw without disturbing gestalt, which is just what the great majority of the controls do. This suggests that among the patients we are indeed dealing with a minority group who do not differ essentially from senescent "normals" in respect of construction. In these groups (all controls and "non-G" patients) executive disturbance appears with complexity probably <u>because</u> a large measure of visual perceptual control over motor activity is preserved, which can recognise and make adjustments for faulty construction while performance is still going on.

<u>COPYING BENDER-GESTALT DESIGNS</u>. The two groups differ in their capacity to achieve gestalt. Such failure is rare among controls. The characteristic of the designs in this series is so heterogeneous that it is difficult to consider it as a series at all. It may be of some interest that Items 1, 2 and 3 whose gestalt suffers most severely in patients' drawings does not show a specially selective failure in the drawings of controls.

<u>REPRODUCING BENDER-GESTALT DESIGNS FROM IMMEDIATE MEMORY</u>.

Both groups show errors of gestalt more prominently in this condition of construction. The increase is proportionately greater in patients

however. Executive errors occur with much the same frequency in both groups. Examination of the responses in both groups suggests that the design has been perceived but "fades" within seconds while drawing is in progress (see p. 229 Discussion). 23 patients conveyed the gestalt of Item 8 in copying but only 7 in reproduction from immediate memory. For controls the figures are 18 and 15 respectively. Patients therefore fail to retain a visually perceived image forlong enough to get it down on paper. There is a similar tendency in controls but it is by comparison slight.

DRAW A HOUSE, MAN, TREE, BICYCLE.

By the standards laid down for correct scoring, performance by both groups is poor, but errors of gestalt, common in patients, are rare in controls. No control subject, for instance, asked to draw a man, fails to convey the recognisable idea of a man in his response.

When only those among the patients who succeed in conveying gestalt in drawing a house are compared with controls, unusual results emerge. Two kinds of executive error can be defined in these responses, viz. spatial errors, and errors of lines and angles. They tend to be mutually exclusive in controls and occur together in patients. Defects of lines and angles are much more common in patients than controls and twice as common as spatial errors in the patient group itself.

The four objects drawn in this test, and the house in particular, can be regarded as complex designs. The house has a quality of gestalt which depends on a unique arrangement of certain "minor" gestalten none of whose forms is highly specific. These are the crosses, squares, circles and rectangles by which the subject portrays doors, windows, chimneys, etc. Alone, these "minor" forms would not be recognisable

for the parts of the house, which a special arrangement of them turns out to be. The elements which make up these "minor" forms have no specificity at all. They are merely the straight and curved lines which are the raw material of all forms.

On page 231 (Discussion) it was shown that a group of those patients who fail to achieve recognisable form, do nevertheless draw general forms which are appropriate to the class of object asked for. These drawings conspicuously lack the "minor" forms referred to above.

These last two findings raise the question as to how the patient does in fact achieve gestalt. The last mentioned finding suggests that he can contrive total form but not the special arrangement of "minor" forms, which gives the total form definition and incidentally renders it recognisable. Control results appear to contradict this view. 17 out of 20 control subjects show disturbance of the placing of minor forms (spatial errors). Nevertheless errors of gestalt among controls are absent or rare. None of these spatial errors in control drawings is of course severe, and though a chimney may be rotated or one side of a window missing, the relationship of these faulty parts to all the other component parts is "good" for the whole design in question. Indeed in control drawings, the existence of well-placed component parts alone without the framework of walls is sufficient to convey the idea of the object (e.g. SR. in drawing a house).

We must distinguish therefore between the gestalt, which some patients portray by drawing a square box, and the identity of the whole form which is only achieved by a special arrangement of "minor" forms within the space which the gestalt should occupy. It is this special arrangement within the gestalt space which is lacking in those patients who attempt, but fail, to draw a house.

What is perhaps curious is that in the drawings of controls there are so many spatial defects. In controls' drawing of a house, apart from frequent omission of parts of the "minor" forms and sides of the outline framework itself, there are rotations (of chimneys) and displacements (of doors, roofs and chimneys). The character of these defects is such, that they could not be explained in terms of lack of skill in drawing technique. Rotation of the chimney occurs in both cases in relation to a sloping roof. The chimney appears to be cocked at the angle it is, so that it can form a right angle to the part of the roof upon which it stands. It suggests that orientating the chimney correctly at right angles to the ground is difficult when the base upon which it must immediately rest is not itself parallel to the ground; that the diagonal base influences the drawing of the chimney so as to make it at right angles to itself.

By comparison with patient errors discussed elsewhere this defect is rather sophisticated, for on examination of patients' drawing of a house none has unambiguously "dared" to draw the chimney on the sloping part of the roof and therefore none has exposed himself to the possibility of this type of error.

MANNIKIN. The contrast between patient and control performance is great, even judged in terms of correct scores. The distributions are very different. 19 patients succeed in identifying the scattered parts. 14 of these 19 assemble the pieces in a way which is recognisable as a human form. Of the 21 patients who fail to identify the scattered parts only 4 assemble the pieces as a recognisable form. All the controls identify the parts and all assemble in a recognisable way. The significance of the relationship between visual identification and construction has already been discussed (see p.232 - Discussion).

COPYING PLAIN BLOCK DESIGNS. Like the mannikin test there is a striking difference between the performance of patients and controls purely in terms of correct scores. There distributions are very different. The 20 controls copy all designs perfectly. Only 8 out of 40 patients achieve that level of performance.

REPRODUCTION OF PLAIN BLOCK DESIGNS FROM IMMEDIATE MEMORY.

The distributions of patient and control scores are again very different but the overlap is greater than in direct copying.

Items 1, 2 and 4 appear to present less difficulty to both groups than the other items.

Three factors were described in the section on results which had to be considered by the subject trying to deal with this series of items. These were number of blocks, dimension of design and symmetry of design. The question which remains in doubt is whether one of these factors only, or predominantly, determines the quality of response or whether more than one is responsible.

Consideration of patient and control results suggests that the number of bricks in an item is a stronger influence on quality of performance in reproduction from immediate memory than in direct copying, whatever the influence of the other factors is. This is hardly surprising, if there is any substance to the view expressed on p.229(Discussion), that design fails to be retained, by fading while response is in progress. An eight block response must take longer to construct than a three block one, and thus give greater opportunity for loss of whatever plan of construction the subject has chosen to retain.

The loss just referred to is clearly greatly more frequent in patients than controls.

KOHS' BLOCKS.

The distribution of correct responses is quite different. Both groups show a marked drop in the frequency of correct responses as the test proceeds from Item 1 - 5. The striking difference between the patient and control groups in the performance of this test lies in their ability to construct the block design of 4 or 9 bricks, irrespective of the design thereon.

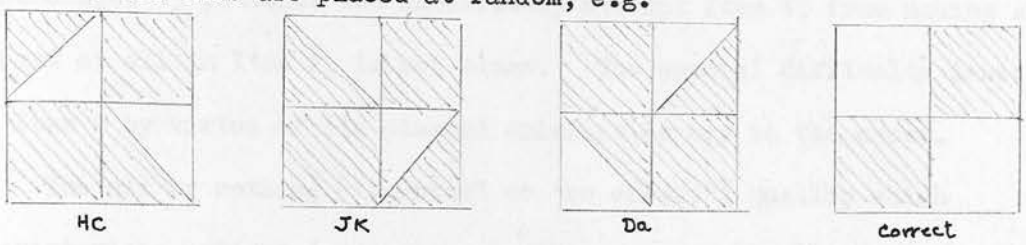
PERCENTAGE OF CORRECT BLOCK DESIGNS IN KOHS.

Item	1	2	3	4	5
Patients	55	30	25	12.5	2.5
Controls	100	95	80	75	70

The best performance in patients judged in this way, is not as good as the worst in controls. It is difficult to judge the patient performance in terms of the design on the surface of the block design. 8 of the 30 patients who attempted the task in Item 1, failed to achieve the correct block design. It is clear that the need to consider the many variables which this task contains inhibits the best performance the patient is capable of in respect of one of these variables, viz. the construction of a simple block design.

3 patients (HC. Da. JK.) achieve roughly correct general design but incorrect detail of the surface design. A large group are unable to construct the simplest level of square orientated surface design. The most primitive organised efforts to achieve this design, however, show that certain prominent aspects of the design (the red bricks) are achieved, but the bricks which complete the design and serve to contrast

with the red ones are placed at random, e.g.



It will be noticed that Da. does not even achieve the correct diagonal axis for the red bricks. All controls construct Item 1 correctly.

By Item 2, the control and patient groups differ more severely. In patients' results it is clear that if the subject cannot perform correctly he tends not to perform at all. There are, in other words, very few incorrect attempts. In those few however, the diamond-orientated nature of a part of the design contributes strongly to error. Du., M'N. and AP. all show unsuccessful efforts to deal with the diamond orientation and, in two cases, Du. and M'N., successful effort in dealing with the square-orientated part of the design.

In the early attempts by controls at Item 2 four subjects make the kind of error just described; namely a failure in orientating the two blocks comprising the diamond-orientated part of the design and success in orientating the blocks comprising the square-orientated part of the design. Total neglect of the task does not occur in controls' performance of Item 2.

In this test therefore one of the causes of failure appears to be the same for patients and controls. Whether it is valid to assume, that those patients who made no effort to begin the task of construction in Item 2, did not do so for the reason just discussed, is in doubt. The support for that assumption is only slight. Three other patients (EC. M'D., Ri.) who successfully construct Item 1, fail Item 2. What it is that

discourages 15 patients who incorrectly attempt Item 1, from making any effort at all in Item 2, is not clear. The special difficulty inherent in Item 2 by virtue of its diamond orientation may be the cause.

The all or nothing ("correct" or "no effort") quality which characterises patients' responses in Item 2, suggests that the patient is willing to engage in trial and error activity in some circumstances but not in others. This would suggest that the patient subject makes some level of judgment at a glance about the nature of the structure of the design he is faced with. We know, and he "knows" that square-orientated design is perhaps within his capacity. He attempts it, however unsuccessfully. We know and he "knows" on the other hand that diamond-orientated design is beyond his capacity and, perhaps therefore, he does not even begin to try.

PLASTICINE STICKS.

There is considerable overlap in the distributions of patients and controls, though in the latter group scoring is higher. There is a striking similarity between the two groups about the quality of the errors in this test. In both groups Designs 7, 8 and 10 score lowest. In both groups Design 9 scores highest of the three-dimensional designs. The error designated as "reduction to symmetry" is most prominent in Designs 8 and 10 in both groups; and lastly, in both groups, those who attempt designs and fail, nevertheless generally succeed in placing the vertically orientated sticks but fail to place horizontally and diagonally orientated sticks. The diagonally orientated sticks are least often placed correctly.

The possible significance of these findings has already been discussed.

CONCLUSION.

CONCLUSION.

Diamond orientated simple designs present seniles with greater difficulty than square orientated designs. Design, which has a central axis on each side of which are mirror images, presents greater difficulty when that axis is not vertical than when it is.

There is a tendency for patients attempting to draw diamond orientated design to rotate them towards square orientation. Patients show a similar tendency to rotate symmetrical designs whose central axis is diagonal so that the central axis becomes vertical. There is even a tendency among patients to reduce design which has no symmetry about any axis to a form which is symmetrical about the central vertical axis already described. It is suggested that the influence of the square orientation of the paper used in drawing may be responsible for these phenomena, and that it is an over-influence because the usual guide to the construction of diagonally orientated design is lacking.

The proposition is made that this usual guide is in normal circumstances, the proper awareness of body verticality which in seniles may be lacking, leaving other cues to exercise undue influence.

Design can be roughly classified in as much as it presents difficulty to seniles. The greatest difficulty is encountered in asymmetrical design, less in symmetrical design where the central axis is not vertical, and least in symmetrical design where the central axis or plane is vertical.

A further hierarchy of difficulty is outlined on evidence from the results, which suggests that diagonally, horizontally and vertically orientated forms are, in that order, (most to least) difficult to construct.

The more complex is any design, the more difficulty does it impose

upon the senile patient. Where complexity is beyond perceptual capacity those aspects of the complex forms which are diamond orientated are those which fail to be perceived and reproduced thereby distributing the perception and reproduction of the whole form.

Diamond orientated shapes are more easily perceived and reproduced where complex design is less elaborate.

Perception, in the restricted sense of recognition of design, fails in seniles and is a factor determining faulty reproduction.

In certain non-drawing (i.e. manipulative) constructional tasks the process requires attention to a limited number of identifiable variables viz. number of units of construction, number of dimensions, and symmetry of design. There is no evidence that any one of these in seniles has a primary influence on the frequency of faulty construction. There is some evidence that seniles fail to construct designs when the number of variables rating "high" in complexity is great, rather than when variables rating "high" in complexity is small in number. Sensitivity to changes in the level of complexity in these tasks is greater in the condition of reproduction from immediate memory than in direct copying. In a task where the number of variables is very high (Koh's) aspects of construction are not achieved, which are achieved in a similar task with a smaller number of variables (plain block design). It is suggested that for seniles the need to consider a large number of variables in itself inhibits the best performance the senile patient is capable of, in respect of any one of these variables.

Results suggest that executive ability is more severely taxed in seniles by direct copying than by spontaneous reproduction of the same

designs. It is suggested that the need for specificity is greater in the former than in the latter. In copying the patient must not only perceive a gestalt but analyse and reproduce the dimensions of a particular one. In spontaneous reproduction he must recall a gestalt but he is under no obligation to reproduce one of specific dimensions.

Results suggest that the reproduction of gestalt is more severely taxed in spontaneous reproduction than in direct copying. In the former the subject depends upon his visual memory as the reference for design. Reference is to a present model in the latter.

It is concluded from these results that the identification of the class to which a design belongs, and the analysis of the dimensions of a particular design within that class, are perceptual tasks of a different order which are differentially affected in senile dementia.

There is evidence that, when the need for specificity is at its greatest, as in Abelson's figures, then execution disturbance reaches a severity which may also distort gestalt.

Comparison of results suggest that factors which make for difficulty in tests of spontaneous reproduction, and reproduction from immediate memory, are similar in that they both are concerned with memory; but it is suggested that the main factor concerned in spontaneous reproduction is a failure of recall, and in reproduction from immediate memory a failure of retention. The design is perceived, but not retained as long as it takes to reproduce it.

In the construction of certain complex designs (draw a house) patients show themselves able to portray and differentiate the object in so far as it belongs to a general class of objects (square) but not with the

specificity that would convey the special nature of the object (house) within that class.

In comparing patient and control responses, the patient group, test for test, was invariably worse than the control group. A small group of "superior" patients fell within the control range of performance when a general assessment of results was compared. The construction of square orientated design is not essentially different between the two groups but diamond orientated design whose construction breaks down in senlies does not fail conspicuously in controls.

A small group of patients, and all controls, show a common tendency to increasing executive disturbance in construction with increased complexity of design. It is suggested paradoxically that the preservation of a large measure of visual control over motor activity while the task of construction is in progress, accounts for this phenomenon. It might be inferred in turn that in the majority of seniles the ability just described is lacking.

A small group of designs in the Bender-Gestalt series (items 1-5) which are especially poorly performed in patients do not noticeably hinder controls. This suggests that in patients the final gestalt is less likely to be constructed when the smallest unit of construction is less than the continuous line, or, in other words, where the line itself becomes a sub-gestalt requiring construction.

The difficulty of patients, compared with the relative success of controls, in drawing a house suggests that there are different factors concerned in portraying a recognisable gestalt. One is the construction of a shape which merely establishes the general class of object to which the particular one belongs. Its special identity depends upon a

specific arrangement of minor gestalten which controls achieve in spite of defects of omission, displacement and rotation which are in this study defined as spatial and which other writers (Critchley 1953) have described as characteristic of constructional apraxia.

Both patients and controls show the same quality of difficulty in retaining a visually perceived form long enough to construct it. It is seen moreover that in those designs containing the largest number of units of construction the probability of "fading" is greater, simply because the manipulation of a large number of units takes longer than a small number.

In the most complex constructional task (e.g. Koh's) comparison between patient and control groups can only be made with regard to one of its primitive features, viz. its block design as opposed to its surface design. The patient does not necessarily neglect the various aspects of a complex task but the need for consideration of them, all at once, in itself determines failure. Where the task is at its most complex patients differ from normals in making no effort to construct at all. It is suggested that seniles make judgments, on the basis and at the stage of visual inspection, as to whether a design can be constructed by them or not.

The cases described in this series do not differ from the cases upon which Kleist[5] (1934) based his notion of constructive apraxia in that, to a large extent, they showed frank and prominent disorientation in space. They are similar also in showing as a group little or no apraxia of single movement. The pattern just described was also a feature of

the cases of those authors who described constructional apraxia in association with right-hemisphere lesions, where there was "disorganisation of discriminative spatial judgment" or "spatial agnosia" or "conceptual spatial impairment". That there is a disturbance of spatial judgment in the series of cases at present under consideration is hardly in question. The study has attempted to define the nature of spatial disturbance in senile dementia more precisely and give it more definition. In short it finds that this morbid group fails to construct those aspects of design which are not vertically orientated and more particularly those aspects which are not symmetrical about a median vertical axis or sagittal plane. Moreover it shows that a group tends to create symmetry and rotate axes towards the vertical, where response demands non-vertical and asymmetrical design.

To use Stengel's [14] (1944) manner of summing up, one might say that these cases have replaced the complex organisation of spatial relations in the environment by a primitive notion of space the only features of which are verticality and symmetry, and not "nearness" as he postulates.

It has been suggested tentatively in the discussion of the results in this study that this peculiar spatial defect may depend upon the uninhibited influence, on the senile subject performing these tasks, of the overwhelmingly square and vertically orientated nature of most objects in the environment andmost immediately of the square orientation of the paper and table upon which he draws and manipulates. In pursuit of this hypothesis it was further suggested that disinhibition may occur because the sense of body verticality is disturbed. On closer examination of Kleist's [5] (1934) paper ataxic disturbance and dizziness are mentioned quite incidentally in some of his cases. Hecaen et al [21] (1951) frankly, though not exclusively, account for constructional apraxia, in their

right hemisphere lesion cases, in terms of central vestibular disturbance. Brengelmann[26] (1957) relates the orientation of the body to the ability to perceive the vertical or non-vertical orientation of objects in space.

These are interesting findings which relate spatial defect to faulty awareness of body posture. They do not conclusively support the tentative suggestion made at the beginning of the preceding paragraph, but they do suggest that further lines of study might be illuminating.

The spatial defect just discussed might be regarded as the one specific to the task of construction as performed by seniles. Good construction in this series of cases however, also fails for reasons other than the specific spatial one.

Complexity of the kind defined in this study may be a feature of any perceptual task, and is therefore a general characteristic. Faced with the general characteristic of complexity in the particular task of construction the senile patient's performance breaks down in a special way. Where design is so complex that it is beyond his perceptual capacity he fails in that part of the task which faces him with specific spatial difficulty. Where the complexity of design is within perceptual capacity the specific defect may not be expressed.

To some extent therefore there is a disturbance of spatial analysis only beyond certain limits of complexity.

The results of this study suggest that motor activity in constructional behaviour depends on at least two discrete preliminary stages. The first is visual recognition or recall of the design. The second is a process

of analysis of spatial dimensions according to which motor activity is planned. The process of analysis must be more meticulous, and therefore more difficult for seniles, in copying than spontaneous construction.

Mayer-Gross [9] (1936a) himself postulates a complex of sequential events (see p. Introduction) in the constructional process, which is similar to the stages just described. His conclusion about the nature of constructional apraxia however loses force in describing "construction" as part of the process. There is no evidence in his work, as there is none in this study, to support the notion that the purely motor part of the task is really disabled. The faulty finished product, in seniles at any rate, may represent faulty recognition of design or a failure to make an analysis of the design appropriate to the material at hand. In other words ultimate failure may be determined before motor activity begins at all. This is perhaps just another way of saying that constructional apraxia is merely a defect of spatial judgment. It is hoped that the nature of that spatial defect has been given definition in this study.

SUMMARY.

1. The performance of a series of 13 visuo-constructive tasks by 40 patients with senile dementia (mean age 77.87 years) and 20 aged control subjects (mean age 77.55 years) is studied. The aim of the investigation is to define the nature of constructional defect within the patient group.

2. The wide heterogeneity of problems posed by conventional testing of constructional ability is discussed.

3. In the consideration of results an attempt has been made to isolate major common factors. Executive and gestalt failures are defined as occurring under three conditions of direct copying, spontaneous construction and reproduction from immediate memory, and the patient and control groups are contrasted.

4. Other aspects of response not isolated as common features are described discursively.

5. In the discussion of results it is concluded that the morbid group under study fail to construct diamond-orientated rather than square-orientated design. They fail to construct design which has no line of symmetry, rather than design which has, and they fail to construct design which has a diagonal line of symmetry rather than a vertical one.

6. Patients in faulty response show a tendency to reduce design to symmetry and to the vertical, when it should properly be asymmetrical and non-vertical.

7. Horizontal design poses more difficulty to the experimental group than vertical, but not so much as diagonal design.

8. Where complexity as defined in this study is beyond perceptual capacity, those aspects of the design which are diamond-orientated are those which fail to be perceived and constructed; though they may be perceived and constructed in less complex designs.

9. Failure of visual recognition of design can alone be a cause of faulty construction in seniles.

10. In senile patients the need to consider a large number of variables, in a task, in itself may inhibit the best performance the patient is capable of in respect of any one of these variables.

11. The identification of the class to which a design belongs, and the analysis of the dimensions of a particular design within that class, are perceptual tasks of a different order differentially affected in senile dementia.

12. In spontaneous construction recall fails. In reproduction from immediate memory retention fails when the task of construction is still in progress.

13. Patient group is worse than control group performance in every test. There are 6 'superior' patients whose performance falls within the control range. Qualitative differences between control and patient groups are discussed.

14. In more complex construction control subjects show defects similar to those described as occurring in constructional apraxia of focal origin.

15. The patient group in this study shows evidence of a specific spatial defect which is similar to that described by authors considering constructional apraxia as an outcome of focal brain damage. In this

study other general causes of constructional failure have also been defined. It is suggested that the specific spatial perceptual defect determines failure in the constructional act even before purely motor manipulation activity begins.

16. It is tentatively suggested that the spatial defect outlined in this study may be a consequence of loss of awareness of body verticality, allowing the mainly square or vertical orientation of objects in the environment to exert an undue influence upon the patients' perceptual function.

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